Atlantic OCS
Proposed Geological and Geophysical Activities

Mid-Atlantic and South Atlantic Planning Areas

Biological Assessment

U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

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ACRONYMS AND ABBREVIATIONS

µPa	micropascal(s)
µs	microsecond(s)
2D	two-dimensional
3D	three-dimensional
4D	four-dimensional
ABR	auditory brainstem response
ac	acre(s)
AEP	auditory evoked potential
AIM	Acoustic Integration Model
ALWTRP	Atlantic Large Whale Take Reduction Plan
AOI	Area of Interest
ASMFC	Atlantic States Marine Fisheries Commission
AUV	autonomous underwater vehicle
BA	Biological Assessment
bbl	barrel(s)
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BSEE	Bureau of Safety and Environmental Enforcement
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
COE	U.S. Army Corps of Engineers
COP	Construction and Operations Plan
COST	Continental Offshore Stratigraphic Test
CPT	cone penetrometer test
CSEM	controlled source electromagnetic
dB	decibel(s)
DOD	Department of Defense
DPS	distinct population segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAZ	full azimuth
FERC	Federal Energy Regulatory Commission
ft	feet
FWS	U.S. Fish and Wildlife Service
G&G	geological and geophysical
gal	gallon(s)
GAP	General Activities Plan
GPS	global positioning system
ha	hectare(s)
HESS	High Energy Seismic Survey
hr	hour(s)
HRG	high-resolution geophysical
Hz	hertz
IAGC	International Association of Geophysical Contractors
in.	inch(es)
IPF	impact-producing factor
ISSMGE	International Society for Soil Mechanics and Geotechnical Engineering
JNCC	Joint Nature Conservation Committee

kg	kilogram(s)
km	kilometer(s)
kn	knot(s)
L	liter(s)
lb	pound(s)
LFA	low frequency active
LNG	liquefied natural gas
m	meter(s)
MARAD	Maritime Administration
MHK	marine hydrokinetic
MHW	Mean High Water
mi	mile(s)
min	minute(s)
ml	milliliters
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
ms	millisecond(s)
MSD	marine sanitation device
MT	magnetotelluric
MW	megawatt(s)
NASA	National Aeronautics and Space Administration
NDBC	National Data Buoy Center
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRDC	National Resources Defense Council
NRU	Northern Recovery Unit
NSF	National Science Foundation
NTL	Notice to Lessees and Operators
NWP	Nationwide Permit
NWR	National Wildlife Refuge
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODMDS	ocean dredged material disposal site
OPAREA	Operating Area
PAM	passive acoustic monitoring
PBR	Potential Biological Removal
PCPT	piezocone penetration test
PFRU	Peninsular Florida Recovery Unit
P.L.	Public Law
ppm	parts per million
PTS	permanent threshold shift
rms	root-mean-square
ROD	Record of Decision
ROV	remotely operated vehicle
s	second(s)
SAFMC	South Atlantic Fishery Management Council
SAP	Site Assessment Plan
SBF	synthetic-based fluid
SCDNR	South Carolina Department of Natural Resources
SEL	sound exposure level
SMA	Seasonal Management Area

SPL	sound pressure level
SURTASS	Surveillance Towed Array Sensor System
TED	turtle excluder device
TTS	temporary threshold shift
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDHS	U.S. Department of Homeland Security
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VACAPES	Virginia Capes
VSP	vertical seismic profiling
WAZ	wide azimuth
WBF	water-based fluid
WEA	wind energy area
WFF	Wallops Flight Facility

1. INTRODUCTION

1.1. BACKGROUND

The Bureau of Ocean Energy Management (BOEM) is proposing to authorize geological and geophysical (G&G) activities in support of its oil and gas, renewable energy, and marine minerals programs in Federal waters of the Mid- and South Atlantic Outer Continental Shelf (OCS). The BOEM has prepared a Draft Programmatic Environmental Impact Statement (EIS) to evaluate the potential environmental impacts of the proposed action and alternatives in accordance with the National Environmental Policy Act (NEPA) (42 United States Code [U.S.C. 4321] *et seq.*) as implemented by Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1500-1508). This Biological Assessment (BA) was prepared by BOEM in accordance with Section 7 of the Endangered Species Act (ESA) of 1973 (ESA, Public Law [P.L.] 93-205), which requires that all Federal agencies ensure that any action they authorize, fund, or carry out will not jeopardize the continued existence of any threatened or endangered species (i.e., listed species) or result in the destruction or adverse modification of any critical habitat of such species (50 CFR 402).

The BOEM is the lead agency on this BA because it has the jurisdiction to authorize G&G activities on the OCS. The BOEM manages the exploration and development of the nation's offshore resources. It seeks to appropriately balance economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development, and environmental reviews and studies. This BA is also being submitted on behalf of the Bureau of Safety and Environmental Enforcement (BSEE)[1], which promotes safety, protects the environment, and conserves resources offshore through vigorous regulatory oversight and enforcement. The BSEE does not have jurisdiction to authorize G&G activities on the OCS, but is responsible for ensuring compliance with mitigation measures and would review all protected species observer reports for compliance.

This BA applies only to G&G activities that would be conducted in the Mid-Atlantic and South Atlantic Planning Areas, which are under BOEM jurisdiction. Because the Area of Interest (AOI) for the Programmatic EIS includes adjacent State waters (outside of estuaries) and waters beyond the Exclusive Economic Zone (EEZ) extending to 350 nautical miles (nmi) (648 kilometers [km] or 403 miles [mi]) from shore (**Figure A-1**), the BA discusses some G&G activities that could occur outside the two OCS planning areas. However, to the extent practicable, the BA identifies and focuses on G&G activities that would occur in Federal waters under BOEM's jurisdiction. Activities in State waters, which represent about 1 percent of the AOI, could require authorization by the U.S. Army Corps of Engineers (COE) under its Nationwide Permits (NWP) program; the COE declined servings as a cooperating agency in preparing the Draft Programmatic EIS and was not involved in preparing this BA. Waters seaward of the two OCS planning areas are not within BOEM's jurisdiction, and G&G activities there would not require authorization from any Federal agency, although the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS), Permits and Conservation Division has permitting authority for incidental takes of marine mammals associated with those activities under Section 101(a)(5) of the Marine Mammal Protection Act (MMPA).

1.2. PURPOSE AND NEED

The purpose of the proposed action is to gather state-of-the-art data about the ocean bottom and subsurface. These data, collected through G&G surveys, would provide information about the location and extent of oil and gas reserves, bottom conditions for oil and gas or renewable energy installations, and marine minerals off the Atlantic coast of the U.S. State-of-the-art G&G data and information are required for business decisions in furtherance of prospecting for OCS oil and gas in an orderly manner, assessing

[1] On October 1, 2011, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) was replaced by the BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) as part of a major reorganization. Corresponding to this reorganization, on October 18, 2011 (*Federal Register*, 2011a) the Code of Federal Regulations (CFR) Title 30 was reorganized. Regulations that are to be administered by BSEE remain in Title 30 CFR Chapter II under that Agency's name (30 CFR 250), and the regulations that are to be administered by BOEM were moved into a new Title 30 CFR Chapter V under BOEM's name (30 CFR 550).

sites for renewable energy facilities, or using marine mineral resources in the Mid- and South Atlantic Planning Areas (**Figure A-1**). The G&G surveys acquired during the period when Atlantic oil and gas leasing took place in the 1970's and 1980's have been eclipsed by newer instrumentation and technology that make seismic data of that era inadequate for business decisions to lease and develop these OCS lands or to evaluate the environmental impacts of potential leasing and development.

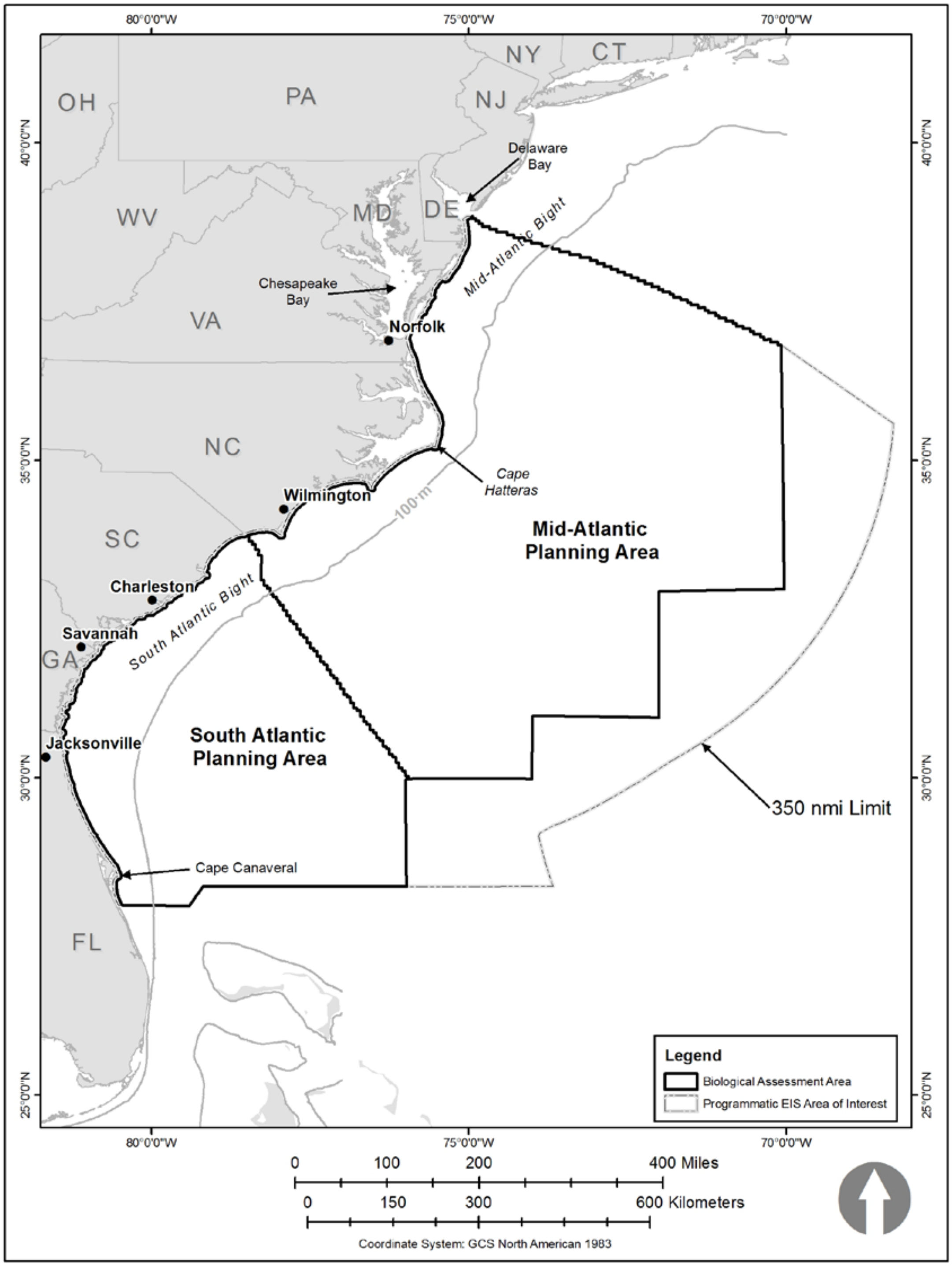


Figure A-1. Biological Assessment Area for the Proposed Action. The Biological Assessment Area consists of the Mid-Atlantic and South Atlantic Planning Areas.

The need for the proposed action is to use the information obtained by the G&G surveys to make informed business decisions regarding oil and gas reserves, engineering decisions regarding the construction of renewable energy projects, and informed estimates regarding the composition and volume of marine mineral resources. This information would also be used to ensure the proper use and conservation of OCS energy resources and the receipt of fair market value for the leasing of public lands.

The purpose of the BA is to evaluate the potential effects (both direct and indirect) of the proposed action on listed species and designated critical habitat and determine whether any such species or habitats are likely to be adversely affected by the action (50 CFR 402.12). The BA will be used by BOEM, BSEE, NMFS and the U.S. Fish and Wildlife Service (FWS) to consult under Section 7(a)(2) of the ESA.

2. PROJECT DESCRIPTION

2.1. GEOGRAPHIC LOCATION

2.1.1. Area of Interest for the Draft Programmatic EIS

The AOI for the Draft Programmatic EIS (**Figure A-1**) includes U.S. Atlantic waters from the mouth of Delaware Bay to just south of Cape Canaveral, Florida, and from the shoreline (excluding estuaries) to 648 km (350 nmi) from shore. It includes a portion of the Mid-Atlantic Bight, which extends from Cape Cod to Cape Hatteras, North Carolina; and all of the South Atlantic Bight, which extends from Cape Hatteras to Cape Canaveral, Florida.

The northern (38°51' N) and southern (28° N) limits of the AOI are based on the boundaries of the Mid-Atlantic and South Atlantic Planning Areas. The seaward limit of 648 km (350 nmi) from shore is based on the maximum constraint line for the extended continental shelf under Article 76 of the United Nations Convention on the Law of the Sea (U.S. Extended Continental Shelf Task Force, 2010). Along most of the Atlantic coast where the shoreline consists of barrier islands and beaches, the shoreward boundary is the Mean High Water (MHW) line. A straight line was drawn across inlets and the mouths of estuaries and embayments.

The size of the AOI is 854,779 km^2 (330,032 mi^2), and the two OCS planning areas account for 79 percent of the total area. The area within State waters is 9,174 km^2 (3,452 mi^2), or about 1 percent of the AOI. Waters beyond the outer boundaries of the two planning areas represent an area of 168,898 km^2 (65,211 mi^2), or 20 percent of the AOI. Water depth within the AOI ranges from 0-5,629 meters (m) (0-18,468 feet [ft]).

2.1.2. Biological Assessment Area

This BA Area consists of the Mid-Atlantic Planning Area (456,818 km^2 or 176,378 mi^2) and South Atlantic Planning Area (219,890 km^2 or 84,900 mi^2). Together these account for 79 percent of the AOI analyzed in the Draft Programmatic EIS. The two planning areas do not include any waters under State jurisdiction. On the Atlantic coast, State jurisdiction extends 3 nmi (5.6 km) from shore.

The types of G&G activities that BOEM is proposing to authorize are organized within three broad program areas: oil and gas exploration and development, renewable energy development, and marine mineral activities. The geographic locations of activities with the three program areas is summarized as follows:

- Oil and gas exploration and development – these G&G surveys are the most extensive activities in the proposed action and are expected to occur almost exclusively within the two OCS planning areas under BOEM jurisdiction.
- Renewable energy development – these surveys are expected to occur within both Federal and State waters less than 100 m (328 ft) deep (U.S. Department of the Interior [USDOI], Minerals Management Service [MMS], 2007a). This represents an area of 132,167 km^2 (51,029 mi^2), or about 15 percent of the AOI. Approximately 93 percent of the area within the 100-m (328-ft) isobath is in Federal waters under BOEM jurisdiction.

- Marine mineral activities (e.g., sand and gravel mining) – these activities are expected to occur in both Federal and State waters less than 30 m (98 ft) deep. This represents an area of 76,330 km^2 (29,471 mi^2), or about 9 percent of the AOI. Approximately 88 percent of the area within the 30-m (328-ft) isobath is in Federal waters under BOEM jurisdiction.

2.2. PROPOSED ACTION

2.2.1. Introduction

A variety of G&G techniques are used to characterize the shallow and deep structure of the shelf, slope, and deepwater ocean environments. G&G surveys are conducted to (1) obtain data for hydrocarbon exploration and production, (2) aid in siting renewable energy structures, (3) locate potential sand and gravel resources, (4) identify possible seafloor or shallow depth geologic hazards, and (5) locate potential archaeological resources and potential hard bottom habitats for avoidance. The selection of a specific technique or suite of techniques is driven by data needs and the target of interest. The G&G activities evaluated as part of this BA are described in this section, and their applicability to the three program areas (oil and gas, renewable energy, and marine minerals) are summarized in **Table A-1**. The activities include the following:

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

The following sections describe the types of G&G activities that BOEM is proposing to authorize under the proposed action within the three broad program areas (oil and gas exploration and development, renewable energy development, and marine minerals). Mitigation and monitoring measures included in the proposed action are discussed in **Section 7**. Additional details of the equipment and activity levels in the proposed action scenario are presented as part of the impact analysis in **Section 5**.

2.2.2. Oil and Gas Exploration and Development Surveys

2.2.2.1. Types of G&G Surveys

The oil and gas industry conducts a variety of G&G activities, both pre-lease and post-lease. Typical pre-lease activities include deep penetration seismic airgun surveys to explore and evaluate deep geologic formations. Two-dimensional (2D) seismic airgun surveys usually are designed to cover thousands of square miles or entire geologic basins as a means to geologically screen large areas. Three-dimensional (3D) surveys can consist of several hundred OCS blocks and provide much better resolution to evaluate hydrocarbon potential in smaller areas or specific prospects. Other pre-lease surveys include largely passive data gathering methods such as electromagnetic, gravity, and magnetic surveys, as well as remote sensing surveys from aircraft and satellites.

Table A-1

Types of G&G Activities Included in the Proposed Action

Survey Type	Applicable Program Areas			Purpose(s)
	Oil and Gas	Renewable Energy	Marine Minerals	
Deep Penetration Seismic Surveys				Evaluate subsurface geological formations to assess potential hydrocarbon reservoirs and optimally site exploration and development wells. 4D surveys are used to monitor reservoirs over time during production.
2D Seismic Exploration Surveys	X	x[a]	--	
3D Seismic Exploration Surveys	X	x[a]	--	
Wide Azimuth Surveys	X	--	--	
Nodes and Bottom Cable Surveys	X	--	--	
Vertical Cable Surveys	X	--	--	
4D (Time-Lapse) Surveys	X	--	--	
Vertical Seismic Profile Surveys	X	--	--	
High-Resolution Geophysical Surveys				Assess shallow hazards, archaeological resources, and benthic habitats.
With single airgun as seismic source	X	--	--	
With boomer or chirp subbottom profiler as seismic source	--	X	X	
Electromagnetic Surveys				Help distinguish economic hydrocarbon accumulations from other scenarios by using electromagnetic signals to develop a conductivity/resistivity profile of the seafloor.
Controlled Source Electromagnetic Surveys	X	--	--	
Magnetotelluric Surveys	X	--	--	
Deep Stratigraphic and Shallow Test Drilling				COST wells evaluate stratigraphy and hydrocarbon potential without drilling directly into oil and gas bearing strata. Shallow test drilling is conducted to place test equipment into a borehole to evaluate gas hydrates or other properties.
Continental Offshore Stratigraphic Test (COST) Wells	X	--	--	
Shallow Test Drilling	X	--	--	
Bottom Sampling				Collect surface and near-surface sediment samples to assess seafloor properties for siting structures such as platforms, pipelines, or cables.
Cone Penetrometer Tests	X	X	X	
Vibracoring	X	X	X	
Geologic Coring	X	X	X	
Grab Sampling	X	X	X	
Remote Sensing				Gravity and magnetic surveys are used to assess structure and sedimentary properties of subsurface horizons. Aeromagnetic surveys evaluate deep crustal structure, salt related structure, and intra-sedimentary anomalies.
Gravity Surveys	X	--	--	
Gravity Gradiometry	X	--	--	
Marine Magnetic Surveys	X	--	--	
Aeromagnetic Surveys	X	--	--	

[a] The renewable energy scenario includes the possibility that a deep penetration (2D or 3D) seismic survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

Post-lease activities conducted by operators can include additional seismic airgun surveys, HRG surveys, and bottom sampling (including stratigraphic wells, shallow test wells, and geotechnical sampling). Examples of post-lease seismic airgun surveys include vertical seismic profiling (VSP) with geophone receivers placed in a wellbore, and four-dimensional (4D) (time-lapse) surveys to monitor reservoirs during production. The HRG surveys are conducted on leases and along pipeline routes to evaluate the potential for geohazards, archaeological resources, and certain types of benthic communities. Geotechnical sampling is conducted to assess seafloor conditions with respect to siting facilities such as platforms and pipelines.

Categories of G&G activities conducted for oil and gas exploration are described below.

Deep Penetration Seismic Airgun Surveys

Deep penetration seismic airgun surveys are conducted by industry to obtain data on geological formations down to several thousand meters below the seafloor. During these surveys, a survey vessel tows an array of airguns that emit acoustic energy pulses into the seafloor. Acoustic characteristics of airgun arrays are discussed as part of the impact analysis in **Section 5.2**. The acoustic signals reflect (or refract) off subsurface layers having acoustic impedance contrast and are recorded by hydrophones that are towed on streamers behind the ship or positioned on the seafloor as autonomous nodes or cables, or in rare instances spaced at various depths in vertically positioned cables. Data from these surveys can be used to assess potential hydrocarbon reservoirs and help to optimally locate exploration and development wells, thus maximizing extraction and production from a reservoir.

The 2D and 3D streamer surveys are the most extensive types of seismic survey included in the proposed action. A 2D dataset is acquired by using wider line spacing and is used to identify regional structural geology and to link known productive areas over large geographic areas. In contrast, 3D seismic data enable industry to identify, with greater precision, where the most economical prospects may be located. The 3D technology is also used to identify previously overlooked hydrocarbon-bearing zones and new productive horizons. However, because 3D modeling requires much denser data coverage (i.e., closer line spacing) than 2D seismic surveys, areas already covered using 2D techniques may be resurveyed. Further, 3D surveys may be repeated over producing fields to characterize production reservoirs. These 4D, or time-lapse 3D, surveys are used predominantly to evaluate post-reservoir variance over time as a reservoir monitoring tool.

2D Seismic Exploration Surveys. The 2D seismic exploration surveys are conducted by geophysical contractors either on a proprietary or speculative basis. Speculative surveys are generally conducted over large multi-block areas and can be sold to numerous clients to recover costs, whereas proprietary surveys usually cover only a few blocks for an individual client that will have exclusive use of the data. Although the number of 2D surveys is small compared to 3D surveys, they are important as the 2D surveys can cover a larger area in less detail, resulting in a lower cost per area covered. Each geophysical contractor has a proprietary method of data acquisition that may vary depending on their seismic target and data processing capabilities. This makes each contractor's data set unique and does not lend itself to combining with other surveys.

Ships conducting 2D surveys are typically 60-90 m (200-300 ft) long and tow a single source array 100-200 m (328-656 ft) behind the ship and about 5-10 m (16-33 ft) below the sea surface. The source array typically consists of three subarrays of six or seven airguns each and measures approximately 12.5-18 m (41-60 ft) long and 16-36 m (52-118 ft) wide. Following behind the source array by 100-200 m (328-656 ft) is a single streamer approximately 5-10 km (2.7-5.4 nmi) long. The ship tows this apparatus at a speed of about 4.5-6 knots (kn) (8.3-11 km/hour [hr]). About every 16 seconds (s) (i.e., a distance of 37.5 m [123 ft] for a vessel traveling at 4.5 kn [8.3 km/hr]), the airgun array is fired; the actual time between firings varies depending on ship speed.

While surveying, the ship travels down a track for 12-20 hr (i.e., a distance of 100-166 km [54-90 nmi] for a vessel traveling at 4.5 kn [8.3 km/hr]), depending on the size of the survey area. Upon reaching the end of the track, the ship takes 2-3 hr to turn around and start down another track. The spacing between tracks is usually on the order of 2 km (1.1 nmi). This procedure takes place day and night and may continue for days, weeks, or months, depending on the size of the survey area.

3D Seismic Exploration Surveys. As with 2D surveys, almost all 3D seismic exploration surveys are conducted by geophysical contractors as speculative or multi-client surveys conducted over large, multi-block areas. Proprietary surveys are also conducted over only a few blocks. Conventional, single-vessel 3D surveys are also referred to as narrow azimuth 3D surveys.

Ships conducting 3D surveys are generally 80-90 m (262-295 ft) long, or slightly larger than those used in 2D surveys since they are towing more equipment. These ships typically tow two source arrays aligned in parallel with one another 100-200 m (328-656 ft) behind them. The two source arrays are identical to each other and are the same as those used in the 2D surveys described previously. Following another 100-200 m (328-656 ft) behind the dual source arrays are 6-12 streamer cables 3-8 km (1.6-4.3 nmi) long and spread out over a breadth of 600-1,500 m (1,969-4,922 ft).

The survey ship tows the apparatus at a speed of 4.5 kn (8.3 km/hr). About every 16 s (i.e., a distance of 37.5 m [123 ft] for a vessel traveling at 4.5 kn [8.3 km/hr]), one of the dual airgun arrays is fired; the other array is fired 16 s later. To achieve the desired spacing, the time between firings varies depending on ship speed. While surveying, the ship travels down a track for 12-20 hr (i.e., a distance of 100-166 km [54-90 nmi] at 4.5 kn [8.3 km/hr]), depending on the size of the survey area. Upon reaching the end of the track, the ship takes 2-3 hr to turn around and start down another track. This procedure takes place day and night and may continue for days, weeks, or months, depending on the size of the survey area.

Wide Azimuth and Related Multi-Vessel Surveys. In single-vessel 3D surveys, only a limited subset of the reflected wave field can be recorded because of the narrow range of source-receiver azimuths. New methods such as wide azimuth (WAZ), rich azimuth, multi-azimuth, and wide azimuth towed-streamer acquisition have emerged in the last few years to improve the data resolution problems inherent in traditional marine seismic surveys. These new methods provide seismic data with better illumination, higher signal-to-noise ratio, and improved resolution.

Wide, rich, and multi-azimuth acquisition configurations involve multiple vessels operating concurrently in a variety of source vessel-to-acquisitional vessel geometries. Several source vessels (usually two to four) are used in coordination with single or dual receiver vessels either in a parallel or rectangular arrangement with a 1,200-m (3,937 ft) vessel spacing to maximize the azimuthal quality of the data acquired. It is not uncommon to have sources also deployed from the receiver vessels in addition to source-only vessels; this improves the signal-to-noise ratio, helps illuminate complex geology in sub-salt areas, and provides natural attenuation of multiple reflections from the water surface.

Full azimuth (FAZ) or coil surveys are a further refinement of the WAZ acquisition of subsalt data and are a proprietary acquisitional technique developed by WesternGeco (Schlumberger). These surveys can consist of a single source/receiver arrangement or a multi-vessel operation with multiple sources, with seismic data being acquired while the vessels follow a circular to spiral path. This method was initially developed as a single-vessel alternative to WAZ surveys but has evolved into a multi-vessel technology.

Nodes and Ocean Bottom Cable Surveys. Ocean bottom cable surveys were originally designed to enable seismic surveys in congested areas, such as producing fields with their many platforms and production facilities. New technology has also allowed for autonomous receiving units (nodes) to be deployed by remotely operated vehicles (ROVs). These surveys have been found to be useful for obtaining four-component (4C) data (seismic pressure, as well as vertical and two horizontal motions of the water bottom, or seafloor), yielding more information about the fluids and rock characteristics in the subsurface. With standard hydrophones, these surveys can be conducted to about 183 m (600 ft), but with newer technology can be conducted at water depths of up to 2,500 m (8,200 ft) or more.

Autonomous nodes and ocean bottom cable surveys require the use of multiple ships (usually two ships for cable layout/pickup, one ship for recording, one ship for shooting, and two smaller utility boats). These ships are generally smaller than those used in streamer operations, and the utility boats can be very small. Operations begin by deploying the nodes in equally spaced grids by means of an ROV or by dropping cables off the back of the layout boat. Cable length is typically 4.2 km (2.3 nmi) but can be up to 12 km (6.5 nmi). Groups of seismic detectors (usually hydrophones and vertical motion geophones) are attached to the nodes and cable in intervals of 25-50 m (82-164 ft). Multiple nodes and cables are laid parallel to each other with a 50-m (164-ft) interval between cables. When the node or cable is in place, a ship towing a dual airgun array passes between the cables, firing every 25 m (82 ft). Sometimes a faster source ship speed of 6 kn (11 km/hr) instead of the normal 4.5 kn (8.3 km/hr) speed is used, with an increase in time between airgun firings.

After a source line is acquired, the source ship takes about 10-15 minutes (min) to turn around and pass down between the next two nodes or cables. When a node or cable is no longer needed to record seismic data, it is retrieved by the ROV or cable pickup ship and moved to the next recording position. A particular node or cable can lay on the bottom anywhere from 2 hr to several days, depending on operation conditions. In some cases, nodes or cables may be left on the bottom for future 4D (time-lapse) surveys (see below).

Vertical Cable Surveys. Vertical cable surveys, although uncommon, are similar to ocean bottom cable surveys in that the receivers are deployed and then acoustic data are output by a source vessel. However, they are substantially different from ocean-bottom surveys in that the receivers are located at several locations along a vertical cable that is anchored to the ocean bottom.

These surveys can be conducted in water depths up to about 2,500 m (8,200 ft). Two identically configured boats are used during a vertical cable survey. Both boats are used initially to place the cables. During the survey, one boat is used as a source boat and the other to recover and redeploy the cables. The vertical cables are deployed on two overlapping grids. On each grid, vertical cables are deployed every 2 km (1.1 nmi). One grid is staggered relative to the other such that any one vertical cable is no more than 1.4 km (0.75 nmi) from its closest neighbor. Normally, 28 or 32 vertical cables are deployed at a time.

At the bottom of each vertical cable is an anchor composed of 680 kilograms (kg) (1,500 pounds [lb]) of steel. The active section of the cable is 375 m (1,230 ft) long and contains 16 specially constructed hydrophones spaced 25 m (82 ft) apart. At the top are buoyant floats to keep the cable as vertical as possible. Once the cables are in place, the source boat begins shooting in such a way that each vertical cable receives shots at a distance of 5 km (2.7 nmi) in all directions. This is accomplished by traveling down lines parallel to the grid of vertical cables. Once the shooting boat shoots a line 1 km (0.54 nmi) beyond the first row of vertical cables, that row is recovered and redeployed. Cables may be left in place for hours or days, depending on the size of the survey area and operating conditions. Vessel speed is normally 4-5 kn (7.4-9.3 km/hr). The dual airgun array is the same as normally used in 3D streamer surveys.

4D (Time-Lapse) Surveys. The 3D surveys may be repeated over oil and/or gas producing fields to characterize production reservoirs. These 4D or time-lapse surveys are becoming more frequent as the technology for analyzing the data is developed. The purpose of 4D surveys is to monitor the depletion of the reservoir and locate zones of bypassed production in an already discovered oil or gas field. A time-lapse survey requires repeated surveys with highly accurate navigation to ensure the same subsurface points are measured on each survey. Time-lapse surveys are usually repeated every 6 months to a year, but occasionally the repeat interval can be as short as 4 months.

Time-lapse surveys can use either seismic streamer cables or ocean-bottom cables to house the seismic detectors. In either case, the procedure closely resembles those described previously for 3D and ocean-bottom cable surveys. The main difference is in the size of the survey area. Since the oil or gas field already has been located, the survey area is much smaller and survey time is much shorter. An average survey takes 2-4 weeks and can cover 20 km^2 (5.8 nmi^2). Although the technique initially used streamer cables, the difficulty in locating sensors with suitable precision led to the use of bottom cables, then to fixed bottom cables. When fixed bottom cables are used, the survey time, after the first survey, is much shorter since all that has to be done is connect the fixed bottom cable to the recording instruments and start shooting.

Vertical Seismic Profile Surveys. Vertical seismic profiling is a technique carried out by placing geophone receivers down a borehole at different depths, and with an external acoustic source near the wellbore (zero-offset VSP) or on a vessel at different distances from the wellbore (walk-away VSP). These surveys are used to obtain information about the nature of the seismic signal, as well as more information about the geology surrounding the vertical array of sensors. The VSP data can be cross-correlated with ship-towed seismic survey datasets to refine identification of lithologic changes and the content of formation fluids. Zero-offset and walk-away VSP surveys are common during the development and production phases of activity.

In all VSP surveys, sensors are lowered down a borehole before production tubing is placed in the wellbore or the well is abandoned. The sensors lowered down the borehole can be connected together in strings of 16-36 receivers spaced from 15-150 m (49-492 ft) apart, depending on the survey objective and other variables. After lowering the sensor string to the lowest portion of the borehole to be surveyed, the sensors are temporarily clamped to the side of the wellbore and seismic signals are recorded. Subsequently, the sensors are repositioned and the next set of seismic signals recorded. Seismic sources used in VSP surveys are the same as those used in conventional seismic airgun surveys. Zero offset surveys are conducted using a small-volume, single airgun suspended by a crane located on the deck of the drilling rig.

Walk-away surveys utilize a workboat with only four to eight airguns. The same airgun arrays used for conventional 2D and 3D surveys are used for 3D VSP surveys. These airgun arrays can vary from 1,000-5,000 in.^{3}, depending upon the depth of the objective. Typical airgun array depths are 7-10 m (23-33 ft) below the surface. One method used to provide 3D coverage is for the source vessel to travel in a spiral track. The source vessel begins the spiral track at a distance of 200 m (656 ft) from the borehole and keeps the distance between spirals equal to the number of arrays times the array separation. First, one airgun array fires, then 12-14 s later the other airgun array fires. At a typical vessel speed of 4.5-5 kn (8.3-9.3 km/hr), the distance between firings is between 28 and 36 m (92 and 118 ft). The source vessel continues on the spiral path out to a distance of up to 9 km (4.9 nmi). If the borehole sensor string needs to be raised to another level, the whole procedure is repeated.

Survey duration depends on the type of survey, objectives, cost of the drilling rig, and equipment used. A zero-offset or walk-away survey can take less than a day. By comparison, a 3D survey may require up to 10 days to complete; however, 30 percent of that time may be with the airguns in standby mode.

High-Resolution Geophysical Surveys

The HRG surveys are conducted by industry to investigate the shallow subsurface for geohazards and soil conditions in one or more lease blocks, as well as to identify potential benthic biological communities (or habitats) and archaeological resources in compliance with 30 CFR 550.201, 30 CFR 550.207, 30 CFR 550.194, and 30 CFR 250.1007. The data are used for initial site evaluation for drilling rig emplacement and for platform or pipeline design and emplacement. The HRG survey and report outputs are guided by Notice to Lessees and Operators (NTL) 2008-G05 (*Shallow Hazards Program*) (USDOI, MMS, 2008a) and NTL 2005-G07 (*Archaeological Resource Surveys and Reports*) (USDOI, MMS, 2005).

The HRG surveys for oil and gas exploration use several tools including airgun(s), side-scan sonar, magnetometers, shallow and medium penetration subbottom profilers, and single or multibeam depth sounders. All of the tools for both hazards and archaeological surveys are typically run during the same deployment. However, for areas in water depths greater than 200 m (656 ft), BOEM may allow operators to substitute previously collected 3D seismic reflection data for shallow or medium penetration subbottom profiler data (although not for pipeline pre-installation surveys). A typical HRG operation for an oil and gas exploration site consists of a ship towing an airgun about 25 m (82 ft) behind the ship and a 600-m (1,969-ft) streamer cable with a tail buoy. The ship travels at 3-3.5 kn (5.6-6.5 km/hr), and the airgun is fired every 7-8 s (or about every 12.5 m [41 ft]). The other acoustic sources typically are operated concurrently with the airgun array. Typical surveys cover one lease block, which is usually 4.8 km (3 mi or 2.6 nmi) on a side. The BOEM has identified all blocks in the Atlantic OCS as having a high probability for the presence of historic archaeological resources (i.e., shipwrecks) and requires surveys using a 30-m (98-ft) line spacing. Including line turns, the time to survey one block is about 36 hr; however, streamer and airgun deployment and other operations add to the total survey time.

3D high-resolution surveys using ships towing multiple streamer cables have become commonplace. Since multiple streamers are towed, the ships tend to be slightly larger (47 m vs. 37 m [154 ft vs. 121 ft]). Up to six streamers 100-200 m (328-656 ft) long are used with a tri-cluster of airguns. With this system, 66 lines are necessary per block, which take about 5 days to collect.

For post-lease engineering studies involving the placement of production facilities and pipelines in deep water, HRG surveys are often conducted with autonomous underwater vehicles (AUVs) equipped with a multibeam depth sounder, side-scan sonar, and a chirp subbottom profiler. Geophysical contractors have been using AUVs since about 2000 to make detailed maps of the seafloor before they start building subsea infrastructure.

Electromagnetic Surveys

Electromagnetic surveys are often used in conjunction with seismic airgun surveys to help delineate potential oil and gas reservoirs. Many geological processes in the crust and upper mantle of the seafloor involve the interaction of fluid phases with surrounding rock. The conductivities of hydrothermal phases are different from those of host rock, and collectively they offer distinct profiles of electrical conductivity/resistivity, depending on the specific geological process involved. There are two practical electromagnetic techniques applicable to oil and gas exploration: controlled source electromagnetic (CSEM) surveys and magnetotelluric (MT) surveys. The CSEM technique, sometimes referred to as seabed logging, induces very low frequency (typically less than 2 hertz [Hz]) electromagnetic signals into the upper layers of the seafloor via a towed dipole. The signals are propagated laterally to an array of receivers kilometers away. The MT surveys are passive measurement of the earth's electromagnetic fields; in this technique, no electrical currents are induced into the earth, but the receiver device detects the natural electrical and magnetic fields present in the earth.

Deep Stratigraphic and Shallow Test Drilling

Drilling of deep stratigraphic and shallow test wells is typically an off-lease activity, especially in frontier areas, or can be carried out on a leased block if it does not interfere with the leaseholder's activities. These activities may occur infrequently in the BA Area during the time period of the Programmatic EIS. As defined by 30 CFR 551.1, a deep stratigraphic test well must penetrate at least 152 m (500 ft) into the seafloor; otherwise, it is classified as shallow test drilling.

Continental Offshore Stratigraphic Test (COST) wells typically are drilled to obtain information about regional stratigraphy, reservoir beds, and hydrocarbon potential. These wells are drilled away from any potential petroleum-bearing feature to minimize the chance of encountering oil or gas. The data are used to evaluate structural interpretations from geophysical surveys, determine the age of sediments drilled, and estimate the potential for hydrocarbon accumulation and for determining the presence, absence, or quality of gas hydrate deposits. Drilling would be done by conventional, rotary drilling equipment from a drilling rig; the selection of a moored versus dynamically positioned drilling rig would depend on water depth, site-specific seafloor conditions, and rig availability. Shallow test wells are drilled post-lease to allow operators to place wireline testing equipment into a borehole to evaluate subsurface properties such as the presence of gas hydrates. Drilling would be done by conventional, rotary drilling equipment from a drilling barge or boat. It is likely that at least in the South Atlantic Planning Area, in the Blake Plateau region, there will be some interest in a test program for gas hydrates within the proposed action scenario period. These wells could be considered either COST wells or shallow test drilling, depending on the penetration depth.

Bottom Sampling

Coring or grab sampling methods typically are used to obtain sediment samples for geological and/or geotechnical analyses. Geotechnical sampling and testing are used in engineering studies for placement of structures such as platforms and pipelines. Usually, a program of bottom sampling and shallow coring is conducted simultaneously using a small marine drilling vessel.

"Deep" geologic cores are obtained by standard rotary coring. The cores obtained by this method vary in diameter from 3-20 centimeters (cm) (1-8 inches [in.]) and can penetrate several hundred meters beneath the seafloor. Other methods used during geotechnical surveys include vibracorers, gravity corers, piston corers, box corers, and jet probes (Fugro, 2003; International Society for Soil Mechanics and Geotechnical Engineering [ISSMGE], 2005). Bottom sampling involves devices that penetrate only a few centimeters to several meters below the seafloor. Samples of surficial sediments are typically obtained by dropping a piston core or gravity core ("dart"), essentially a weighted tube, to the ocean floor and recovering it with an attached wire line. Grab samplers are one of the most common methods of retrieving sediment samples from the seabed. A grab sampler is a device that collects a sample of the topmost layers of the seabed by bringing two steel clamshells together and cutting a bite from the soil.

Passive Remote Sensing Surveys

Remote sensing surveys use passive detection methods that do not involve a high-energy sound source. Gravity, gravity gradiometry, and marine magnetic surveys are remote sensing surveys typically conducted from ships. Aeromagnetic surveys are conducted by fixed wing aircraft and look for deep crustal structure, salt-related structure, and intra-sedimentary anomalies. Radar imaging is done by satellite and used to detect oil slicks on the sea surface; because BOEM does not permit nor approve radar imaging surveys, this method is not discussed further.

Gravity Surveys. Marine gravity data can be collected with instruments on the seafloor, in boreholes, or in helicopters, but usually on ships. In some cases, the data are collected during a seismic survey. However, the preferred method has been to use dedicated ships (about 50 m [164 ft] long) in order to acquire more precise data. With the advent of global positioning system (GPS) navigation and larger, more stable seismic ships, it is now possible to achieve the same order of accuracy with meters placed in seismic ships as in dedicated ships. Data grids for gravity surveys range from 1.6 by 8 km to 9.7 by 32 km (0.9 by 4.3 nmi to 5.2 by 17 nmi). Helicopters also may be used to collect gravity data, but such surveys are rare because of the logistics required to keep the craft in the air for extended periods far from shore. No helicopter surveys are assumed to occur in the Proposed Action scenario.

Gravity Gradiometry. Measuring the earth's gravity gradient is now possible with the release of Department of Defense (DOD) technology. The instrument is housed in a box located on a 60-m (197-ft) survey ship or fixed-wing aircraft. In shallow water, ships survey a 0.25- by 1-km (0.13- by 0.54-nmi) grid, and in deep water, a 1- by 2-km (0.54- by 1.08-nmi) grid is used. Typically, a 20-block area is selected for survey, and a ship traveling at 11 kn (20 km/hr) can complete a survey in about 2 days. Gravity gradiometry surveys are also conducted with fixed-wing aircraft that fly at a speed of about 100 kn (185 km/hr) and altitudes of 80-100 m (262-328 ft) (DiFrancesco et al., 2009). No gravity gradiometry surveys are included in the Proposed Action scenario; if such a survey were conducted from an aircraft, it would be similar to an aeromagnetic survey (which is discussed below and included in the Proposed Action scenario).

Marine Magnetic Surveys. Marine magnetic surveys measure the earth's magnetic field for the purpose of determining structure and sedimentary properties of subsurface horizons. Magnetic surveys are also conducted to detect shipwrecks. These surveys are usually conducted in conjunction with a seismic survey, allowing the navigation information to be used for both surveys. The development of low-power digital sensors has allowed the sensor package to be towed behind the seismic source array, which has greatly improved operational efficiency of magnetic surveys. The sensor is housed in a cylindrical package measuring approximately 1 m (3 ft) long and 15-20 cm (6-8 in.) in diameter and weighing about 14 kg (31 lb). The electronics package inside the case contains about 1 liter (L) (0.3 gallons [gal]) of chemically inert nontoxic fluid. The sensor is towed behind one of the subarrays of the seismic source array at distances of 50, 100, or 150 m (164, 328, or 492 ft) behind the array, although the 100-m distance is the most common. The sensor is typically towed at a depth of 3 m (10 ft) and makes use of depth devices mounted on the cable to maintain a constant depth. In magnetic surveys for archaeological resources, the instrument is towed 6 m (20 ft) above the seafloor.

Aeromagnetic Surveys. Aeromagnetic surveys are conducted to look for deep crustal structure, salt-related structure, and intra-sedimentary anomalies. The surveys are flown by fixed-wing aircraft flying at speeds of about 250 km/hr (135 kn) (Reeves, 2005). Based on aeromagnetic datasets posted by Fugro Gravity and Magnetic Services (2012) for the northern Gulf of Mexico, most offshore aeromagnetic surveys are flown at altitudes between 61-152 m (200-500 ft) and collect 15,000-60,000 line km (9,320-37,282 line mi) of data. Line spacing varies depending on the objectives, but typical grids are 0.5 by 1.0 mi or 1.0 by 1.0 mi. A broad scale survey may be flown at higher altitudes (e.g., 305 m [1,000 ft]) and use wider line spacing (e.g., 4 by 12 mi or 8 by 24 mi). The magnetic field is measured by either a proton precision or cesium vapor magnetometer mounted in a "stinger" projection from the tail of the aircraft (Reeves, 2005). On occasion, two magnetometers are used to measure not only the total magnetic field but also the vertical gradient of the field.

2.2.2.2. Geographic Scope of G&G Activities

The G&G activities for oil and gas exploration could occur anywhere within the Mid- and South Atlantic Planning Areas. The potential geographic scope is indicated by the nine applications for seismic airgun surveying in the Atlantic that have been received and posted to BOEM's website at http://www.boem.gov/Oil-and-Gas-Energy-Program/GOMR/GandG.aspx. The proposed survey areas collectively encompass most of the BA Area, with considerable overlap.

2.2.2.3. *Projected Activity Levels*

Projected activity levels over the time period analyzed in the Programmatic EIS are shown in **Tables A-2** and **A-3**. To construct a scenario for oil and gas exploration, BOEM had to make some assumptions for how the Mid- and South Atlantic Planning Areas would be administered as Federal lands, and if oil and gas exploration is to be allowed. The current applications for seismic airgun surveying in the Atlantic were reviewed to separate those portions of proposed surveys that cover the Mid- and South Atlantic Planning Areas. Seismic operators were contacted to determine if they still wished to pursue seismic surveying if restricted to only the Mid- and South Atlantic Planning Areas. The BOEM assumes that there will be no lease sale in these planning areas until at least 2018. The earliest that an oil and gas lease sale can take place is 2018, and only if these planning areas are included as part of the BOEM's 2018-2023 5-year leasing program. Leasing in these planning areas is not included in the Proposed OCS Leasing Program for 2012-2017, which was released in November 2011 (USDOI, BOEM, 2011a).

Table A-2

Projected Levels of G&G Activities for Oil and Gas Exploration in the Mid- and South Atlantic Planning Areas, 2012-2020

Year	Mid-Atlantic Planning Area						South Atlantic Planning Area					
	2D (km)	3D (blocks)[a]	WAZ (blocks)[b]	HRG (line km)	VSP (line km)	CSEM (line km)	2D (km)	3D (blocks)[a]	WAZ (blocks)[b]	HRG (line km)	VSP (line km)	CSEM (line km)
2012	0	0	0	0	0	0	0	0	0	0	0	0
2013	83,400	0	0	0	0	0	28,450	0	0	0	0	0
2014	160,950	0	0	0	0	0	56,900	0	0	0	0	0
2015	12,875	0	0	0	0	0	8,050	0	0	0	0	0
2016	64,375	400	0	0	0	3,220	48,300	300	0	0	0	1,600
2017	41,800	200	0	0	0	16,100	38,624	200	0	3,220	0	8,050
2018	16,100	200	100	3,220	0	32,200	32,200	200	100	32,200	0	9,650
2019	16,100	200	100	16,100	160	16,100	8,050	200	200	16,100	320	320
2020	800	300	200	64,375	320	32,200	800	300	200	40,250	480	320
TOTAL	**396,400**	**1,300**	**400**	**83,695**	**480**	**99,820**	**221,374**	**1,200**	**500**	**91,770**	**800**	**19,940**

Abbreviations: 2D = two-dimensional; 3D = three-dimensional; CSEM = controlled source electromagnetic; HRG = high-resolution geophysical; VSP = vertical seismic profile; WAZ = wide azimuth.

[a] 3D surveys include ocean bottom cable and nodal surveys, vertical cable surveys, and 4D (time-lapse) surveys. Typically, one OCS block is 9 mi^2 (23.3 km^2, 2,331 ha, or 5,760 ac).

[b] WAZ estimates include coil shooting (exclusive to WesternGeco).

Authorization of pre-lease seismic airgun surveys can theoretically take place as soon as BOEM completes the NEPA evaluation and if it publishes a Record of Decision (ROD) to authorize G&G activities in these areas. Operation under BOEM authorization, however, will be dependent on the permittee obtaining any additional needed authorizations (i.e., MMPA). The 3D estimates shown in **Table A-2** include ocean bottom cable and nodal surveys, vertical cable surveys, and 4D nodal projects, and the WAZ estimates also include coil shooting (exclusive to WesternGeco).

Table A-3 provides general activity levels for MT surveys; gravity and magnetic surveys; aeromagnetic surveys; COST wells; shallow test drilling; and bottom sampling, but with no breakdown by year or planning area. Activity estimates were not developed for satellite radar imaging as BOEM does not permit or approve these surveys and they are considered *de minimis* activities.

Table A-3

Projected Levels of Miscellaneous G&G Activities for Oil and Gas Exploration in the Mid- and South Atlantic Planning Areas, 2012-2020

Survey Type	Number of Sampling Events	Notes
Magnetotelluric Surveys	0-2 surveys	Hundreds to thousands of line km per survey, or ≤9 OCS blocks; 1-6 months per survey
Gravity and Magnetic Surveys (remote sensing)	0-5 surveys	Hundreds to thousands of line km per survey; 4-12 months per survey. Data typically acquired during seismic surveys (i.e., from ships)
Aeromagnetic Surveys (remote sensing)	0-2 surveys	Hundreds to thousands of line km per survey; 1-3 months per survey
Continental Offshore Stratigraphic Test (COST) Wells	0-3 wells	Penetration >150 m (500 ft). Requires an Environmental Assessment
Shallow Test Drilling	0-5 wells	Penetration <150 m (500 ft)
Bottom Sampling	50-300 samples	Mainly surficial and near-surface sediments; penetration <30 m (98 ft)

2.2.3. Renewable Energy Site Characterization Surveys

It is expected that G&G surveys would be conducted in support of renewable energy development in the Mid- and South Atlantic Planning Areas within the 2012-2020 time period covered by the Programmatic EIS. Under the renewable energy program (30 CFR 585), the need for G&G surveys in support of site characterization and foundation studies are part of a developer's planning to secure a commercial competitive or non-competitive lease on the OCS for renewable energy facilities. Thus, the decision to offer an OCS lease is an actualizing step for G&G activities. The competitive lease process is set forth at 30 CFR 585.210 through 585.225, and the non-competitive process is set forth at 30 CFR 585.230 through 585.232, and was slightly modified by a recent rulemaking on May 16, 2011 (*Federal Register*, 2011b). Most wind energy facilities on the Atlantic OCS will probably track the competitive process.

There are several OCS plans that are part of the renewable energy program, the approval of any of which could result in G&G activities. A staged decision-making process takes place for a commercial development, such as a wind energy facility: (1) BOEM's planning and analysis; (2) lease issuance; (3) approval of a Site Assessment Plan (SAP); and (4) approval of a Construction and Operations Plan (COP). A General Activities Plan (GAP) is processed for rights-of-way under a similar staged approval process for installation of electrical cable in the seabed or for substations supporting an OCS wind energy facility on unleased OCS land or across land leased to a third party.

A NEPA evaluation is part of the approval process for OCS plans under the renewable energy program. A proposed action at a specific location, tool type, and intensity of G&G activity are subjected to evaluation, which may be an Environmental Assessment (EA) or an EIS. Other consultations/authorizations are also potentially required under additional environmental laws (i.e., MMPA.

A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. A lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to actualize plans that must be approved by BOEM before the lessee can move on to the next stage of the process (30 CFR 585.600 and 585.601). With the submission of a SAP, the lessee proposes characterizing activities for the wind resource by constructing a meteorological tower or installing meteorological buoys on the leasehold (30 CFR 585.605 through 585.618). The lessee's SAP must be approved by BOEM before it conducts these "site assessment" activities on the lease. The BOEM may approve, approve with modification, or disapprove a lessee's SAP (30 CFR 585.613). A lessee may proceed directly to the fourth stage, COP submittal, if no site assessment activities are needed to support a COP submittal. In the current operating environment, this scenario is anticipated to occur in only a few exceptional cases. With the submission of a COP, which is a detailed plan for constructing and operating a wind energy facility on the lease, the lessee must also submit information characterizing the areal extent of the site and the seabed foundation conditions that includes the detailed plan for constructing and operating a wind energy facility on the lease

(30 CFR 585.620 through 585.638). The BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR 585.628). The BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR 585.628).

The regulations also require that a lessee provide the results of G&G surveys with its COP, including a shallow hazards survey (30 CFR 585.626 (a)(1)), geological survey (30 CFR 585.616(a)(2)), geotechnical survey (30 CFR 585.626(a)(4)), and an archaeological resource survey (30 CFR 585.626(a)(5)). Although BOEM does not issue permits or approvals for these site characterization activities, BOEM will not consider approving a lessee's COP if the required survey information is not included. Guidance packages report acceptable instrumentation, survey design parameters, and the report outputs that allow BOEM decisions to be made (USDOI, BOEM, 2011b).

Wind energy facilities are currently the only type of renewable energy facility contemplated in the Mid- and South Atlantic Planning Areas although there is potential for additional renewable energy project proposals within the life of this proposed action. The BOEM has received only one plan for a marine hydrokinetic (MHK) project proposal in the Atlantic, but it is located in the Straits of Florida Planning Area, outside the scope of the Programmatic EIS. Specific locations of G&G surveys for renewable energy sites are not known at this time. However, for this programmatic analysis, the general areas for renewable energy projects in the Mid- and South Atlantic Planning Areas from 2012-2020 have been estimated in terms of numbers of OCS lease blocks offshore the states of Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida. The distance from shore for a wind facility is generally defined at the outward limit of its economic viability, currently about 46 km (25 nmi) from shore or 100 m (328 ft) water depth. The BOEM has published Requests for Interest for specific wind energy areas (WEAs) offshore Delaware, Maryland, and Virginia; locations are shown in **Figure A-2**. In May 2011, North Carolina completed a screening exercise to yield candidate areas of OCS lease blocks meeting their criteria for wind facility development. The BOEM has not published Requests for Interest for the states adjacent to the South Atlantic Planning Area (South Carolina, Georgia, and Florida), but activity levels have been estimated for this analysis. Also, the scenario takes into account the Atlantic Wind Connection, a submarine electricity transmission cable proposed to be installed offshore the Atlantic coast from New Jersey, offshore New York City, to Virginia, offshore Norfolk, to facilitate wind energy development.

2.2.3.1. Types of G&G Surveys

Two general types of G&G site characterization surveys are expected to be conducted in support of renewable energy development: HRG surveys and geotechnical surveys. The HRG surveys are conducted to obtain information about subseafloor conditions, shallow hazards, archaeological resources, and sensitive benthic habitats. Typical equipment used in HRG surveys includes single beam or multibeam depth sounders, magnetometers, side-scan sonars, and shallow and medium penetration subbottom profilers. Geotechnical surveys, which involve seafloor-disturbing activities such as cone penetrometer tests (CPTs), geologic coring, and grab sampling, are conducted to obtain information about surface and subsurface geological and geotechnical properties. Information from both survey types is taken into consideration during siting, design, construction, and operation of renewable energy facilities.

Another activity conducted as part of site characterization is the deployment of bottom-founded monitoring buoys in a lease area. The buoys typically would include current meters and other equipment to monitor oceanographic conditions and marine life. The information collected can be used to evaluate the potential for sediment erosion, aid in the design of renewable energy facilities, and provide baseline environmental information for the lease area.

Under certain conditions, BOEM may encourage the use of additional instrumentations and methods such as divers, remote or manned submersibles, video cameras on ROVs, and additional geophysical survey lines. Once an operator submits a SAP, GAP, or COP, BOEM will review the geophysical survey and any other information available to determine the possible presence of sensitive benthic habitats. These include areas where information suggests the presence of exposed hard bottoms of high, moderate, or low relief; hard bottoms covered by thin, ephemeral sand layers; seagrass patches; or algal beds. A survey that includes benthic grab samples and photodocumentation to delineate areas of sensitive benthic habitats may be recommended by BOEM where such features are known to occur or are suspected from previously conducted studies or surveys, or in areas where data are inadequate. Biological surveys are not part of the analysis in the Programmatic EIS.

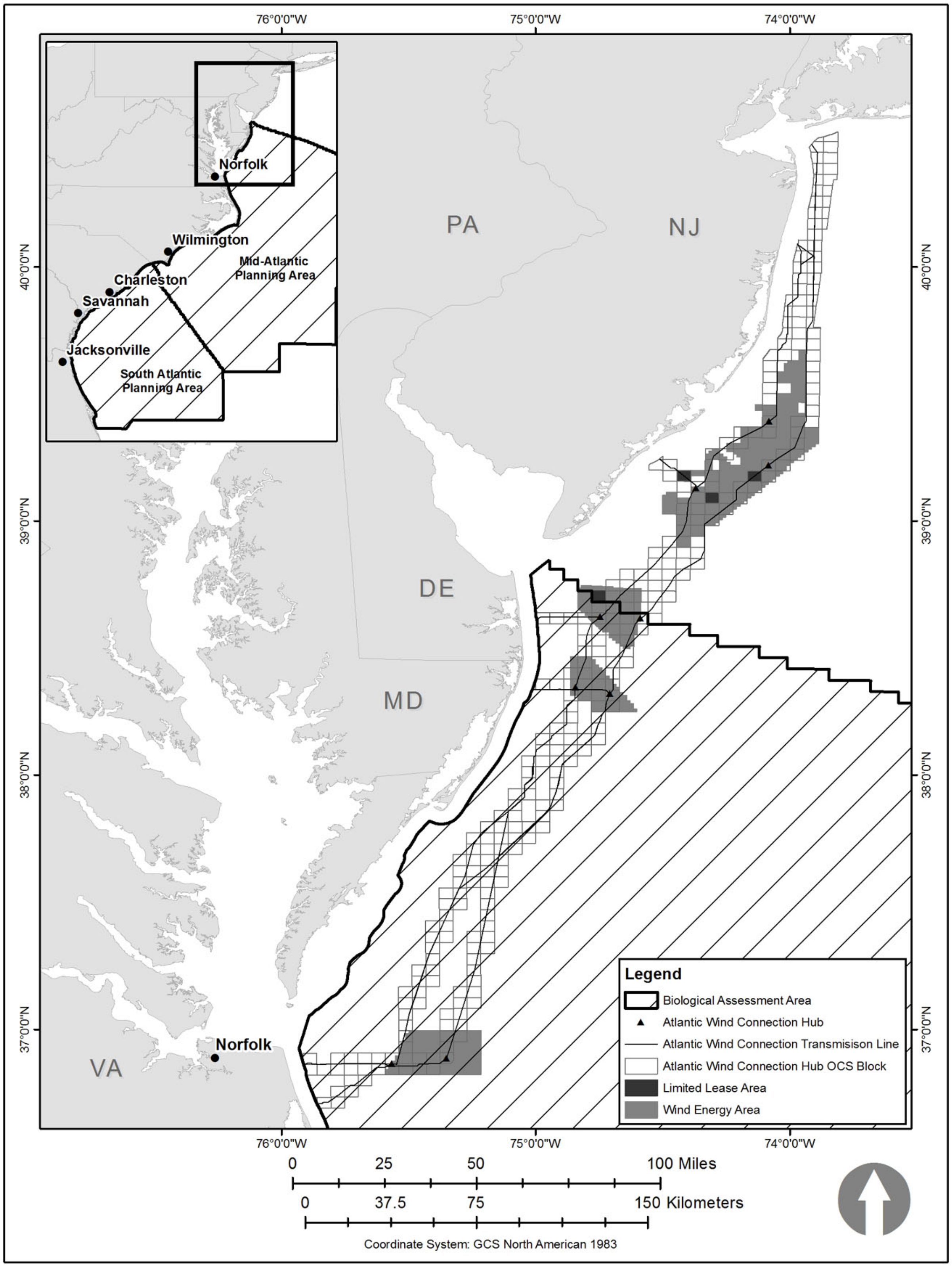


Figure A-2. Identified Potential Wind Energy Facility Project Areas and Limited Leases for Wind Resource Assessment along the Mid-Atlantic Coast. Source: USDOI, BOEM (2012a).

The renewable energy scenario includes the possibility that a deep penetration (2D or 3D) seismic airgun survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic airgun survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

High-Resolution Geophysical Surveys

Lessees must submit the results of site characterization surveys with their SAP (30 CFR 585.610 and 585.611) and COP (30 CFR 585.626 and 585.627). The purpose of the HRG survey would be to acquire geophysical shallow hazards data and information pertaining to the presence or absence of archaeological resources, and to conduct bathymetric charting. The HRG data are collected by lessees to provide information on subseafloor conditions, shallow hazards, archaeological resources, and sensitive benthic habitats in a lease area and along transmission cable corridors. The scope of investigation should be sufficient to reliably cover any portion of the site that would be affected by the renewable energy installation including the maximum area of potential effect encompassing all seafloor/bottom-disturbing activities. The maximum area includes, but is not limited to, the footprint of all seafloor/bottom-disturbing activities (including the areas in which installation vessels, barge anchorages, and/or appurtenances may be placed) associated with construction, installation, inspection, maintenance, or removal of structures and/or transmission cables.

Equipment typically used in HRG surveys for renewable energy includes single beam or multibeam depth sounders, magnetometers, side-scan sonars, and shallow or medium penetration subbottom profilers. The BOEM does not anticipate that airguns would be necessary for renewable energy site assessment activities. Typical equipment is summarized below; see **Chapter 3.5** of the Programmatic EIS for additional information, including sound source levels.

- *Depth Sounders:* The depth sounder system should record with a sweep appropriate to the range of water depths expected in the survey area. The BOEM encourages use of a multibeam bathymetry system, particularly in areas characterized by complex topography or fragile habitats.
- *Magnetometers:* Magnetometer survey techniques should be capable of detecting and aiding the identification of ferrous, ferric, or other objects having a distinct magnetic signature. The magnetometer sensor should be towed as near as possible to the seafloor but should not exceed an altitude of greater than 6 m (20 ft) above the seafloor. The sensor should be towed in a manner that minimizes interference from the vessel hull and other survey instruments. The magnetometer sensitivity should be 1 gamma or less, and the background noise level should not exceed a total of 3 gammas peak-to-peak.
- *Side-Scan Sonars:* Recording should be of optimal quality (good resolution, minimal distortion) resulting in displays automatically corrected for slant range, lay-back, and vessel speed. The operator should use a digital dual-frequency side-scan sonar system with preferred frequencies of 445 and 900 kHz and no less than 100 and 500 kHz to record continuous planimetric images of the seafloor. The recorded data should be used to construct a mosaic to provide a true plan view that provides 100 percent coverage of the area of potential effect. The side-scan sonar sensor should be towed at a distance above the seafloor that is 10-20 percent of the range of the instrument.
- *Shallow and Medium Penetration Subbottom Profilers:* A high-resolution chirp subbottom profiler is typically used to delineate near-surface geologic strata and features. The BOEM recommends that the subbottom profiler system be capable of achieving a vertical bed separation resolution of at least 0.3 m (1 ft) in the uppermost 15 m (49 ft) below the seafloor. The medium penetration boomer profiler system must be capable of penetrating greater than 10 m (33 ft) beyond any potential foundation depth, and the vertical resolution must be less than 6 m (20 ft).

The HRG surveys are conducted from specialized survey vessels fitted with equipment for deploying and handling geophysical systems. In nearshore waters, the surveys would be conducted by a single, small (<23-30 m [75-98 ft]) vessel moving at <5 kn (9.3 km/hr). Typically, a survey would be completed in 3-5 days, and depending on the location, the vessel may return to its shore base daily. Sites in deeper water may require larger vessels that operate 24 hr per day and can remain at sea for weeks. Survey vessels follow precise, pre-plotted lines so that the desired coverage of the seafloor is achieved. An integrated navigational system keeps track of the position and depth of the towed survey equipment.

The BOEM recommends that the geophysical survey grid(s) for project structures and surrounding area for bathymetric charting, shallow hazards assessments, and archaeological resources assessments be oriented with respect to bathymetry, shallow geologic structure, and renewable energy structure locations whenever possible. The grid pattern for each survey should cover the maximum area of potential effect for all anticipated physical disturbances. Specific grid requirements are as follows:

- line spacing for all geophysical data for shallow hazards assessments (on side-scan sonar/all subbottom profilers) should not exceed 150 m (492 ft) throughout the area.
- line spacing for all geophysical data for archaeological resources assessments (on magnetometer, side-scan sonar, chirp subbottom profiler) should not exceed 30 m (98 ft) throughout the area. The BOEM may require higher resolution surveys where necessary to ensure that site-specific actions comply with the National Historic Preservation Act.
- line spacing for bathymetric charting using multibeam technique or side-scan sonar mosaic construction should be suitable for the water depths encountered and provide both full coverage of the seabed plus suitable overlap and resolution of small discrete targets of 0.5-1.0 m (1.5-3 ft) in diameter.
- all track lines should run generally parallel to each other. Tie-lines running perpendicular to the track lines should not exceed a line spacing of 150 m (492 ft) throughout the survey area.

In addition, the geophysical survey grid for proposed transmission cable route(s) should include a minimum 300-m (984-ft) wide corridor centered on the transmission cable location(s). Line spacing should be identical to that noted above.

Geotechnical Surveys

Geotechnical surveys are conducted to obtain information about surface and subsurface geological and geotechnical properties. This information is used to aid in siting, design, construction, and operation of renewable energy facilities. Geotechnical surveys involve seafloor-disturbing activities such as CPTs, geologic coring, and grab sampling. Sediment sampling and testing locations for geotechnical surveys are guided by the geophysical data and maps generated during HRG surveys.

The principal purposes of geotechnical surveys are to (1) assess the suitability of shallow foundation soils to support renewable energy structure(s) or associated transmission cable(s) under extreme operational and environmental conditions that might be encountered; and (2) document soil characteristics necessary for design and installation of all structures and transmission cables. The results reveal the stratigraphic and geoengineering properties of the sediment that may affect the foundations or anchoring systems for the project. Specific uses of geotechnical data are to

- analyze *in situ* and laboratory soil test data to estimate foundation soil response to maximum anticipated static and dynamic loads;
- determine embedment depth and predict susceptibility of the foundation to liquefaction and scour phenomena;
- characterize liquefaction potential, specifically in the context of regional seismicity;
- evaluate the potential for seafloor erosion and scour in the context of empirically derived current velocity data for the project area; and
- integrate the results of the geotechnical and shallow hazards investigations to provide a comprehensive analysis of foundation stability for the site.

The BOEM recommends that the results of *in situ* testing, boring, and/or sampling be analyzed at each foundation location and at every kilometer of the transmission cable route to shore to examine all important sediment and rock strata to determine its strength classification, deformation properties, and dynamic characteristics. Sampling should include a minimum of one "deep" geologic coring (with soil sampling and testing) at each edge of the project area and within the project area as needed to determine the vertical and lateral variation in seabed conditions and to provide the relevant geotechnical data required for design. To be considered a "geologic coring," the core depth should be at least 10 m (33 ft) deeper than the design penetration of the foundation piles. For areas with highly variable subsea soil conditions, it may be appropriate to obtain a much higher number of deep borings than the minimum described in 30 CFR 585.626(a)(4)(iii), and it may be necessary to obtain one at each turbine foundation location to adequately characterize the stratigraphic and geoengineering properties for each foundation design.

Geotechnical surveys for renewable energy sites are expected to be conducted from a small barge or ship approximately 20 m (65 ft) in length. A typical survey duration would be 3 days or less. The spatial scale of sampling and testing activities would range from a minimum of 1/16 of a lease block (approximately 260 hectares [ha] or 640 acres [ac]) to multiple lease blocks and is assumed to include cable route(s) to shore. The area of seabed disturbed by individual sampling events (e.g., collection of a core or grab sample) is estimated to range from 1-10 m^2 (11-108 ft^2). Some operational platforms require anchoring for brief periods using small anchors; however, approximately 50 percent of deployments for this sampling work could involve a boat having dynamic positioning capability. Consequently, not all geological sampling necessarily includes bottom disturbance by anchoring. Jack-up barges and spudded work barges are seldom used.

Cone Penetrometer Tests. The CPT is a widely used *in situ* test for marine engineering applications (Fugro, 2003; ISSMGE, 2005). It is used to obtain information on soil type and stratification as well as shear strength in clays and relative density and friction angles in sand. The CPT provides an empirical assessment of seabed soils based on the resistance of the soil to a cone-tipped probe, or penetrometer, as it is pushed into the seabed at a constant rate of penetration (about 2 cm/s [0.8 in./s]). Standard cones have a tip angle of 60° and a cross-sectional area between 5 and 20 cm^2 (0.8 and 3 $in.^2$). Electrical strain gauges within the cone assembly measure the resistance on the cone tip and friction on a sleeve behind the tip. In a piezocone penetration test (PCPT), an additional parameter, soil pore water pressure, is measured via a porous element in the cone face or at the shoulder between cone tip and friction sleeve. Data are transmitted in realtime to the surface support vessel for recording and analysis.

Geologic Coring. During geotechnical surveys for renewable energy facilities, core samples are collected to characterize the geotechnical properties of surface and subsurface sediments. The BOEM requires that this sampling include a minimum of one "deep" geologic coring (with soil sampling and testing) at each edge of a project area and within a project area as needed to determine the vertical and lateral variation in seabed conditions and to provide the relevant geotechnical data required for design of renewable energy facilities. To be considered a geologic coring, the core depth should be at least 10 m (33 ft) deeper than the design penetration of the foundation piles. Geologic cores are obtained by standard rotary coring. Rotary corers are designed as double or triple tube devices where the innermost tube acts as a core liner, the middle tube, if present, acts as a holder, and the rotating outer tube carries the hollow drill bit. As the bit cuts down through the soils and rock, the core created passes into the liner in a relatively undisturbed state (Fugro, 2003; ISSMGE, 2005). The cores obtained by this method vary in diameter from 3-20 cm and can penetrate several hundred meters beneath the seafloor.

Other methods may be used during geotechnical surveys, including vibracorers, gravity corers, piston corers, box corers, and jet probes (Fugro, 2003; ISSMGE, 2005). These methods are not specifically analyzed here, but the extent of seafloor disturbance would be similar to that for geologic coring.

Grab Sampling. Grab samplers are one of the most common methods of retrieving sediment samples from the seabed. A grab sampler is a device that collects a sample of the topmost layers of the seabed and benthic biota by bringing two steel clamshells together and cutting a bite from the soil. The grab sampler consists of two steel clamshells on a single or double pivot. The shells are brought together either by a powerful spring or powered hydraulic rams operated from the support vessel. The grab is lowered to the seabed and activated, either automatically or by remote control. The shells swivel together in a cutting action and by so doing remove a section of seabed. The sample is recovered to the ship for examination. Geotechnical investigations normally require large samples and favor the bigger hydraulic clamshell grab. These systems can retrieve samples of 0.35 m^3 (12.4 ft^3) or 700 kg (1,543 lb). A typical hydraulic grab sampler will weigh about half a tonne and can operate in water depths down to 200 m (656 ft). Typical sampling rates are between three and four grabs per hour.

Bottom-Founded Monitoring Buoy Deployments

While a meteorological tower has been the traditional device for characterizing wind conditions, several companies have expressed interest in installing meteorological buoys instead (USDOI, BOEM, 2012a). This Programmatic EIS assumes that lessees would choose to install buoys instead of meteorological towers. These meteorological buoys would be anchored at fixed locations and regularly collect observations from many different atmospheric and oceanographic sensors. The scenario does not preclude the use of meteorological towers. Rather, it recognizes that experience to date has shown that operators facing the costs of installing, operating, and decommissioning a meteorological tower have selected against this method for buoys that have near-equivalent capability for obtaining the same data as towers.

Meteorological buoys can vary in height, hull type, and anchoring method. The NOAA has successfully used discus-shaped and boat-shaped hull buoys for weather data collection for many years; these are the buoy types that would most likely be adapted for offshore wind data collection. A large discus buoy has a circular hull that ranges between 10 and 12 m (33 and 39 ft) in diameter and is designed for many years of service (U.S. Department of Commerce [USDOC], National Data Buoy Center [NDBC], 2011). The boat-shaped hull buoy (known as the "NOMAD") is an aluminum-hulled, boat-shaped buoy that provides long-term survivability in severe seas (USDOC, NDBC, 2011). The largest meteorological buoys anticipated in this scenario would be similar to one proposed offshore New Jersey by Garden State Offshore Energy, which was a 30-m (100-ft) long spar-type buoy just over 2 m (6 ft) in diameter (USDOI, BOEM, 2012a).

2.2.3.2. Geographic Scope of G&G Activities

The general area proposed for site assessment activities for renewable energy projects in the Mid- and South Atlantic Planning Areas from 2012-2020 will be a portion of the OCS offshore Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida. Estimated areal extent of the OCS blocks where renewable energy activities may occur offshore each state is summarized in **Table A-4**. The distance from shore for a wind facility is generally defined at the outward limit of its economic viability, currently about 25 nmi (46.3 km) from shore or 100 m (328 ft) water depth. This is generally far enough offshore to minimize interactions with birds and visibility from shore.

Mid-Atlantic Planning Area

In the Mid-Atlantic Planning Area, BOEM published Requests for Interest for WEAs offshore Delaware (*Federal Register*, 2010a), Maryland (*Federal Register*, 2010b), and Virginia (*Federal Register*, 2011b). In January 2012, BOEM issued a final EA for these areas that included changes to the extent of the Maryland and Virginia WEAs (USDOI, BOEM, 2012a). The revised WEAs are the ones included in the Programmatic EIS.

The proposed Delaware WEA rests between the incoming and outgoing shipping routes for Delaware Bay and is made up of 11 whole OCS blocks and 16 partial blocks. The closest point to shore is 18.5 km (10 nmi) due east from Rehoboth Beach, Delaware. The area is approximately 122 nmi^2 (103,323 ac or 41,813 ha).

The Maryland WEA is defined as 9 whole OCS blocks and 11 partial blocks. The western and eastern boundaries of the WEA are located approximately 18.5 and 50 km (10 and 27 nmi), respectively, from Ocean City, Maryland. The area is approximately 94 nmi^2 (79,706 ac or 32,256 ha).

The Virginia WEA consists of 22 whole OCS blocks and 4 partial blocks. The western and eastern boundaries of the area are approximately 33.4 and 68.5 km (18 and 37 nmi), respectively, from Virginia Beach, Virginia. The area is approximately 164 nmi^2 (138,788 ac or 56,165 ha).

Table A-4

Locations and Areas for Renewable Energy Site Characterization and Assessment Activities in the Mid- and South Atlantic Planning Areas

State	Area[a]	OCS Block Equivalents	Description
Mid-Atlantic Planning Area			
Delaware	122 nmi^2 103,323 ac 41,813 ha	18	The Delaware area rests between the incoming and outgoing shipping routes for Delaware Bay and is made up of 11 whole OCS blocks and 16 partial blocks. The closest point to shore is approximately 10 nmi from Rehoboth Beach, DE.
Maryland	94 nmi^2 79,706 ac 32,256 ha	14	The Maryland area is defined as 9 whole OCS blocks and 11 partial blocks. The western edge of the WEA is located approximately 10 nmi from the Ocean City, MD, coast and the eastern edge is approximately 27 nmi from the Ocean City, MD, coast.
Virginia	164 nmi^2 138,788 ac or 56,165 ha	24	The Virginia area consists of 22 whole OCS blocks and 4 partial blocks. The western edge of the area is approximately 18 nmi from Virginia Beach, and the eastern edge is approximately 37 nmi from Virginia Beach.
North Carolina	510 nmi^2 432,002 ac 174,825 ha	75	In May 2011, North Carolina completed a screening exercise to yield a candidate area of 500 OCS lease blocks meeting their criteria for wind facility development. It was a screening exercise for potential environmental suitability and not an area proposed for wind development at this time. It is the expert judgment of BOEM staff that all 500 lease blocks would not be proposed for leasing, or actually leased to begin site assessment activities within the period covered by the Programmatic EIS. A more likely number is that 75 lease blocks will eventually be assessed beginning in late 2012 or early 2013.
South Atlantic Planning Area			
South Carolina	204 nmi^2 172,800 ac 69,930 ha	30	Estimated 30 lease blocks.
Georgia	204 nmi^2 172,800 ac 69,930 ha	30	Estimated 30 lease blocks.
Florida	204 nmi^2 172,800 ac 69,930 ha	30	Estimated 30 lease blocks.
Atlantic Wind Connection Transmission Cable			
New Jersey, Delaware, Maryland, Virginia	0.23 nmi^2 198 ac 80 ha	--	Proposed transmission cable extending from southern New Jersey to Virginia.

[a] Areal extents for Delaware, Maryland, and Virginia are based on Wind Energy Areas designated offshore these states. For the other states, the area is based on the total number of OCS block equivalents, multiplied by an area of 2,331 ha (5,760 ac) per lease block. Calculations for the Atlantic Wind Connection transmission cable are based on a length of 1,320 km (820 mi) and a right-of-way width of 61 m (200 ft).

In May 2011, North Carolina completed a screening exercise to yield a candidate area of 500 OCS lease blocks meeting their criteria for wind facility development (Thrive in North Carolina, 2011). The screening exercise was to determine potential environmental suitability, and the area is not proposed for wind development at this time. It is the expert judgment of BOEM staff that all 500 blocks would not be proposed for leasing or actually leased to begin site assessment activities within the period covered by the Programmatic EIS. Based upon continuing conversations between the State and Federal partners, a more likely number is 75 blocks that will eventually be assessed beginning in late 2012 or early 2013. Based on this assumption, the area would be approximately 510 nmi^2 (432,002 ac or 174,825 ha).

South Atlantic Planning Area

For the states adjacent to the South Atlantic Planning Area (South Carolina, Georgia, and Florida), BOEM has not published Requests for Interest, and there is no other specific information to estimate the activity level in these areas. For this analysis, the activity level has been estimated at 30 lease blocks offshore each of these states. The BOEM has received one plan for an MHK project proposal in the Atlantic, but it is located in the Straits of Florida Planning Area, outside the scope of the Programmatic EIS. It is difficult at this time to estimate the quantity and placement of MHK devices on a commercial scale within a lease block there.

Atlantic Wind Connection Transmission Cable

Atlantic Grid Holdings LLC has proposed to develop a high-voltage direct current transmission cable offshore the Atlantic coast running from northern New Jersey to Virginia in five phases (Atlantic Wind Connection, 2011a,b). The company has requested a right-of-way that is approximately 1,320 km (820 mi) in length, with as many as a dozen offshore platforms (substations). Under BOEM's regulations, a right-of-way is 61 m (200 ft) in width, though the developer may elect to perform surveys on a somewhat wider area to facilitate rerouting should obstructions in the right-of-way be discovered. About 90 percent of the right-of-way is in Federal waters. Although some of the right-of-way is outside the BA Area, for this analysis the entire length is assumed to be within the BA Area.

2.2.3.3. Projected Activity Levels

Table A-5 summarizes the projected activity levels for G&G activities associated with renewable energy development from 2012-2020.

To estimate HRG activity levels, BOEM assumed that geophysical surveys for shallow hazards and archaeological resources would be conducted at the same time using the finer line spacing required for archaeological resource assessment (30 m [98 ft]). Tie-lines would be run perpendicular to the track lines at a line spacing of 150 m (492 ft), which would result in 925 km (575 mi [500 nmi]) of HRG surveys per OCS block. It would take approximately 150 hr to survey one OCS block. In addition, a 16-km (10-mi) cable route to shore was assumed for each state, with a 300-m (984-ft) wide survey corridor requiring about 8 km (5 mi) or 1 hr of surveys per mile of cable. This assumption (1 hr per mile of cable) is also used for the Atlantic Wind Connection submarine transmission cable. In order to survey an entire renewable energy area and potential cable route, HRG surveys would have to be conducted by multiple vessels and/or over multiple years and potential cable routes.

The number of bottom sampling/testing locations for geotechnical surveys was estimated by assuming that a sample would be collected at every potential turbine location. Spacing between wind turbines is typically determined on a case-by-case basis to minimize wake effect and is based on turbine size and rotor diameter. Offshore Denmark, a spacing of seven rotor diameters between units has been used. In the U.S., the Cape Wind project proposed a spacing of 6 by 9 rotor diameters. In some land-based settings, turbines are separated from each other by as much as 10 rotor diameters. Based on this range in spacing for a 3.6-megawatt (MW) (110-m rotor diameter) turbine and a 5-MW (130-m rotor diameter) turbine, it would be possible to place 14-45 turbines in one OCS block. The sampling numbers in **Table A-5** are based on the assumption that a bottom sample would be collected at every potential turbine location in a WEA, at a density of 14-45 turbines per block. In addition, the Atlantic Wind Connection has proposed up to 12 transmission substations along the transmission line, and it is estimated that one or two bottom samples would be collected at each substation.

Table A-5

Projected Levels of G&G Activities for Renewable Energy Site Characterization and Assessment in the Mid- and South Atlantic Planning Areas, 2012-2020

Renewable Energy Area	OCS Block Equivalents	HRG Surveys[a] (max km/hours)	Geotechnical Surveys[b]			Bottom-founded Monitoring Buoys (min-max)	Timing
			CPT (min-max)	Geologic Coring (min-max)	Grab Samples (min-max)		
Delaware	18	16,730/2,710	252–810	252–810	252–810	1–2	2012-2016
Maryland	14	13,030/2,110	196–630	196–630	196–630	1–6	2012-2017
Virginia	24	22,280/3,610	336–1,080	336–1,080	336–1,080	1–6	2012-2017
North Carolina	75	69,455/11,260	1,050–3,375	1,050–3,375	1,050–3,375	1–6	2012-2017
Mid-Atlantic Subtotal	**131**	**121,495/19,690**	**1,834–5,895**	**1,834–5,895**	**1,834–5,895**	**4–20**	**2012-2017**
South Carolina	30	27,830/4,510	420–1,350	420–1,350	420–1,350	1–6	2012-2017
Georgia	30	27,830/4,510	420–1,350	420–1,350	420–1,350	1–6	2013-2018
Florida	30	27,830/4,510	420–1,350	420–1,350	420–1,350	1–6	2013-2018
South Atlantic Subtotal	**90**	**83,490/13,530**	**1,260–4,050**	**1,260–4,050**	**1,260–4,050**	**3–18**	**2012-2018**
Atlantic Connection Transmission Cable	--	6,600/820	12–24	12-24	12–24	--	2012-2020
TOTAL	**221**	**211,585/34,040**	**3,106–9,969**	**3,106–9,969**	**3,106–9,969**	**7–38**	**2012-2020**

Abbreviations: HRG = high-resolution geophysical; CPT = cone penetrometer test.

[a] HRG survey effort per block was assumed to be 925 km (500 nmi), requiring 150 hr to complete. Added 80 km (43 nmi) and 10 hr for surveying one transmission cable route for each state. For the Atlantic Wind Connection transmission cable, the proposed route length of 1,320 km (820 mi) was multiplied by 5 km per kilometer of route.

[b] Geotechnical survey effort was estimated to be 14-45 sampling locations per block based on the potential range of wind turbine densities per block (assuming one sampling location per turbine location). For the Atlantic Wind Connection transmission cable, assumed up to 12 substations with one or two sampling locations per substation.

2.2.4. Marine Minerals Surveys

Some G&G activities in support of marine mineral uses are expected to occur in the BA Area during the 2012-2020 time period. It should be noted that prospecting for and use of sand or gravel in State waters is under jurisdiction of the COE, and G&G surveys are permitted under their NWP Program. Surveys in State waters are not included in this BA. Exact G&G survey locations and durations are not known at this time. However, sand source areas (borrow areas) are typically located in water depths between 10 and 30 m (33 and 98 ft). The cost for transporting sand to shore for beach nourishment or coastal restoration is relatively expensive, so coastal planners first use resources in areas closest to shore. Much of the G&G survey activity is expected to occur within existing borrow sites offshore the Mid-Atlantic and South Atlantic states (see **Figure A-3** for locations).

2.2.4.1. Types of G&G Surveys

Two general types of G&G surveys are expected to be conducted in support of marine mineral uses: HRG surveys and geotechnical surveys. The HRG surveys are conducted to obtain information about subseafloor conditions, shallow hazards, archaeological resources, and sensitive benthic habitats. Typical equipment used in HRG surveys includes single beam or multibeam depth sounders, magnetometers, side-scan sonars, and shallow or medium penetration subbottom profilers. Geotechnical surveys involve seafloor-disturbing activities such as vibracoring, geologic coring, and grab sampling, which are conducted to evaluate the quality of mineral resources for their intended use.

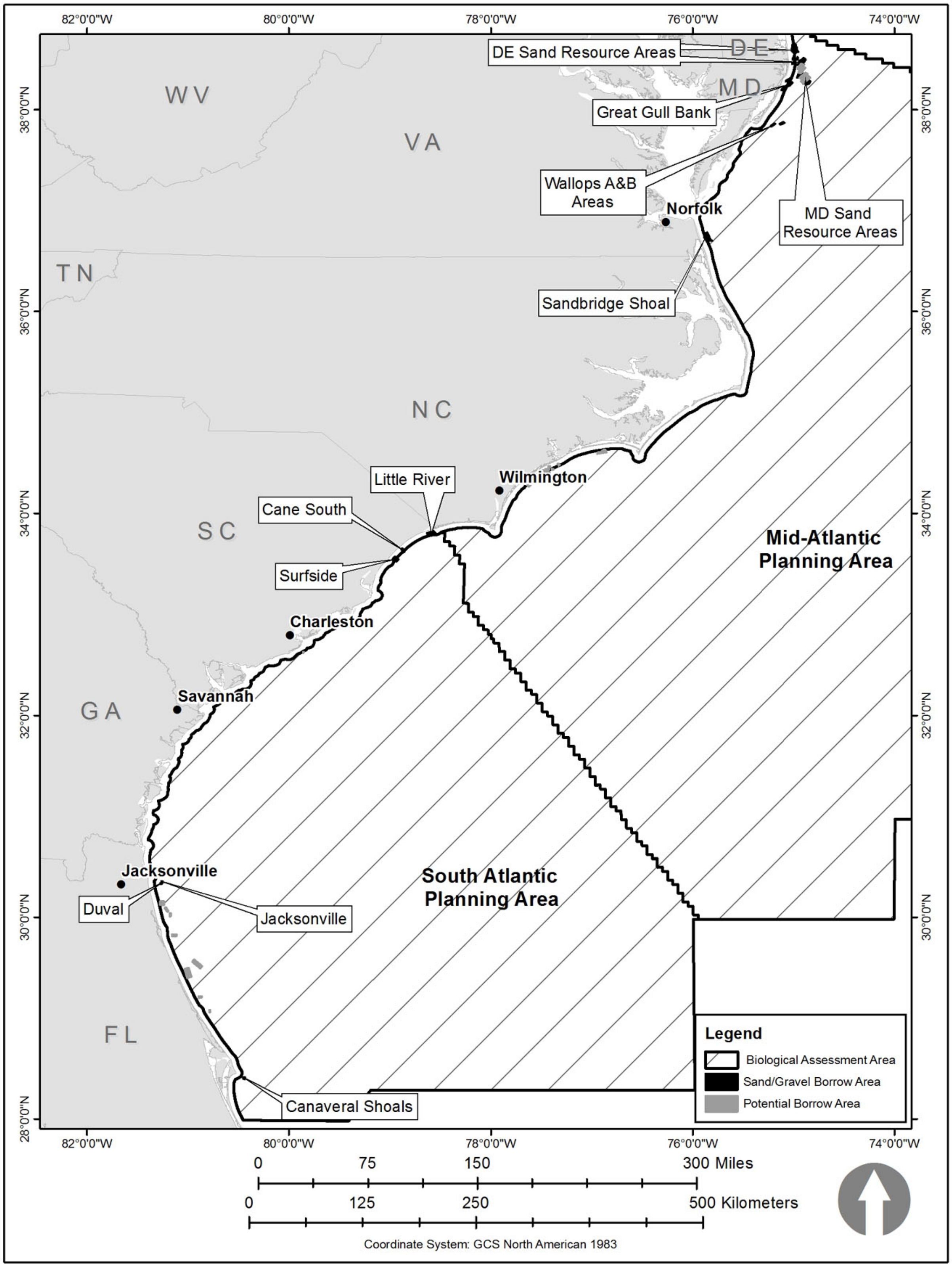


Figure A-3. Outer Continental Shelf Sand and Gravel Borrow Areas along the Mid-Atlantic and South Atlantic Coasts.

High-Resolution Geophysical Surveys

Prospecting and Pre-Lease Geophysical Surveys. The HRG surveys are undertaken to identify OCS sand resources and any environmental resources, cultural resources, and shallow hazards that may exist in potential borrow areas. These surveys are comparable to those undertaken for renewable energy site characterization. Typical survey deployments may involve single beam or multibeam depth sounders, side-scan sonar, a magnetometer, and subbottom profilers (chirp or boomer). Rarely, marine resistivity systems (involving a towed current emitter and an array of receivers) may also be deployed. Geophysical survey equipment is typically deployed from a single relatively small (<20-30 m [65-98 ft]) vessel moving at <5 kn (9.3 km/hr). Survey areas over prospective borrow sites (3-10 km^2 [300-1,000 ha or 741-2,471 ac]) or reconnaissance areas (on the order of 1-3 OCS blocks) are small in comparison to areas for oil and gas and renewable energy site characterization, and these surveys are generally completed in 1-5 operational days.

Prospecting HRG surveys are reconnaissance in nature and generally performed over larger areas to identify sand bodies and characterize the shallow geological framework and surficial geology of potential sand resources. These initial surveys are used to ascertain if sand or gravel resources are of a certain quality (sediment type) and quantity to warrant further exploration and may be conducted at line spacing between 150 and 600 m (492 and 1,969 ft). During the reconnaissance phase, limited geotechnical sampling often occurs along seismic lines and is used to validate geophysical data interpretations.

In comparison, pre-lease (or design-level) HRG surveys are often performed once a relatively smaller area (or areas) is (are) identified as promising borrow area target(s). Pre-lease/design HRG surveys provide information on seafloor/subseafloor conditions, shallow hazards, archaeological resources, and sensitive benthic habitats. These HRG data may be used to prepare a dredging plan to efficiently and economically obtain the needed sand volumes while minimizing adverse environmental impacts. Depending on the quality of the initial reconnaissance geophysical data, these data may also be used to refine the borrow area and/or determine horizontal and vertical continuity of sedimentary units (in which case, the survey may be subject to BOEM authorization). These surveys may be conducted at 15-50 m (49-164 ft) line spacing.

On-Lease Geophysical Surveys. On-lease HRG surveys are typically performed at the borrow area, or a sub-area of the borrow area, prior to and at specified intervals after dredging. A typical area for these surveys would be 1 mi^2 (259 ha or 640 ac). These surveys are used by BOEM to monitor the location and volumes of sand dredging, ensure observance of exclusion zones, and monitor the morphologic evolution of sand bodies and borrow pits. The most frequent geophysical surveys are bathymetric surveys; if sensitive cultural or benthic resources are in the immediate vicinity of dredging and cannot be avoided, side-scan sonar may also be deployed. Since survey areas are relatively small, on-lease geophysical surveys are generally completed in 1-2 days.

Geotechnical Surveys

Geological sampling, most commonly by means of vibracoring, geologic (rotary) coring, and/or grab sampling, is carried out to characterize the volume (footprint and thickness) and quality of a prospective sand body or lens. Geotechnical sampling is most frequently done in connection with reconnaissance geophysical surveying. Of these techniques, vibracoring is the most likely technique used to define the thickness and lateral extent of OCS sand bodies. Other sampling methods such as piston or box coring and jet probes are also used as part of geotechnical surveys but are not specifically analyzed here; the extent of seafloor disturbance would be similar to that of the other sediment sampling methods.

Vibracoring generally is performed with a 7-cm (2.8-in.) diameter core barrel mounted on a platform or tripod support assembly and can penetrate sediments in the upper 15 m (50 ft). To penetrate dense sands and gravels, or to reach deeper into stiff clays, the corer's barrel is vibrated, facilitating its penetration into the soil (Fugro, 2003; ISSMGE, 2005). A typical vibracore survey will obtain 15-25 cores, approximately 6 m (20 ft) deep in a 1 mi^2 (640-ac or 259-ha) area.

Geologic coring (standard rotary coring) varies in diameter from 3-20 cm (1.2-7.9 in.) and can penetrate several hundred meters beneath the seafloor. Because of the significantly greater expense, only one to two geologic cores would typically be drilled in a 1-mi^2 (640-ac or 259-ha) area. Methods have been described previously in **Section 2.2.3.1**. Grab sampling penetrates from a few inches to a few feet below the seafloor and typically involves 30-40 grabs in the area of interest. Methods have been described previously in **Section 2.2.3.1**.

Nearly all geotechnical sampling occurs from either relatively small- to medium-sized stationed vessels approximately 20 m (65 ft) in length or from work barges towed into place. A typical survey duration would be 3 days or less. The area of seabed disturbed by individual sampling events (e.g., collection of a core or grab sample) is estimated to range between 1 and 10 m^2 (11 and 108 ft^2). Some operational platforms require anchoring for brief periods with small anchors; however, approximately 50 percent of deployments for this sampling work could involve a boat having dynamic positioning capability. Consequently, not all geological sampling necessarily includes bottom disturbance by anchoring. Jack-up barges and spudded work barges are seldom used.

2.2.4.2. Geographic Scope of G&G Surveys

The general area where prospecting, pre-lease site assessment, and on-lease G&G surveys in the Mid- and South Atlantic Planning Areas will likely occur from 2012-2020 is in water depths between 10 and 30 m (33 and 98 ft) offshore Delaware south to Florida. Georgia is excluded because the State has never had an agreement with BOEM for joint study of OCS marine minerals resources and has never requested a non-competitive lease to use them onshore. Current technology in the U.S. hopper and cutterhead dredging fleet effectively limits dredging to less than 30-m (98-ft) water depths. Moreover, the cost for transporting sand located in offshore sand shoals and banks to shore is relatively expensive, ensuring coastal planners first use resources in areas closest to shore.

Many OCS usable sand bodies are already known and have been surveyed (USDOI, BOEM, 2011c) and/or used previously. (See **Figure A-3** for a map of existing borrow sites.) When existing sites are reused in the future, additional G&G surveying usually is not required, but may be conducted on a case-by-case basis if needed to detect archaeological resources and other bottom obstructions and to sample the area to see if it can provide the quantity and quality of sand required. Some projects are likely to draw from existing borrow sites over and over again, whereas others may use new areas yet to be drawn from. For this analysis, specific G&G survey locations are not identified. However, based on past usage, a few existing borrow sites such as Sandbridge Shoal offshore Virginia and the Canaveral Shoals and Jacksonville borrow sites offshore Florida are likely to be reused, perhaps accounting for 40-50 percent of future projects.

2.2.4.3. Projected Activity Levels

The Marine Minerals Program has identified beach nourishment and coastal restoration projects that are most likely to require use of OCS sand resources over the next 10 years. Estimated survey levels are summarized in **Table A-6** (for HRG surveys) and **Table A-7** (for geotechnical surveys). The proposed activity scenario is based on an examination of past trends in OCS G&G and leasing activity and anticipated OCS leasing requests, as well as projections of other possible uses as existing borrow areas are nearing depletion. Note that most of G&G prospecting and pre-lease/design surveys have already been completed for most projects.

Table A-6

Projected Levels of High-Resolution Geophysical (HRG) Surveys for OCS Sand Borrow Projects in the Mid- and South Atlantic Planning Areas, 2012-2020

Year	Project	State	Cycle Volume (cubic yd)	Depth (m)	Distance Offshore (km)	Prospecting HRG[a] (line km)		Pre-Lease HRG[a] (line km)		On-Lease HRG[b] (line km)	
						(lower bound)	(upper bound)	(lower bound)	(upper bound)	(lower bound)	(upper bound)
Mid-Atlantic Planning Area											
2012-2013	Wallops Island	VA	3,200,000	9-24	18-20	0	0	0	0	100	501
	Fort Story/Dam Neck	VA	1,000,000	9-20	5	0	0	0	0	31	156
	Sandbridge	VA	2,000,000	9-20	5	0	0	0	0	63	313
2014-2016	Rehoboth/Dewey	DE	360,000	9-20	5	26	642	47	235	11	56
	Bethany/S. Bethany	DE	480,000	9-20	5	34	856	63	313	15	75
	Atlantic Coast of Maryland	MD	800,000	12-16	12-16	0	0	104	522	25	125
	Wallops Island	VA	806,000	9-24	18-20	0	0	0	0	25	126
	Sandbridge	VA	2,000,000	9-20	5	0	0	0	0	63	313
	West Onslow/North Topsail	NC	866,000	13-15	6-9	0	0	0	0	27	135
	Bogue Banks	NC	500,000	13-15	3-5	0	0	65	327	16	78
2017-2020	Rehoboth/Dewey	DE	360,000	9-20	4.8	0	0	0	0	11	56
	Bethany/S. Bethany	DE	480,000	9-20	4.8	0	0	0	0	15	75
	Atlantic Coast of Maryland	MD	800,000	12-16	12-16	0	0	0	0	25	125
	Surf City/North Topsail	NC	2,640,000	12-15	5-8	0	0	0	0	83	413
	Wrightsville Beach	NC	800,000	N/A	N/A	34	856	104	522	25	125
South Atlantic Planning Area											
2012-2013	Patrick Air Force Base	FL	310,000	3-14	3-8	0	0	0	0	10	49
2014-2016	Grand Strand	SC	2,300,000	7-13	4-7	0	0	0	0	72	360
	Brevard County North Reach	FL	516,000	3-14	3-8	0	0	0	0	16	81
	Brevard County Mid-Reach	FL	900,000	3-15	3-8	0	0	0	0	28	141
	Brevard County South Reach	FL	850,000	3-16	3-8	0	0	0	0	27	133
2017-2020	Folly Beach	SC	2,000,000	12-14	5	0	0	261	1306	63	313
	Duval County	FL	1,500,000	14-19	10-11	0	0	0	0	47	235
	St. Johns	FL	N/A	N/A	3-6	N/A	N/A	N/A	N/A	N/A	N/A
	Flagler	FL	N/A	N/A	3-5	N/A	N/A	N/A	N/A	N/A	N/A
	TOTAL										
2012-2020	Mid-Atlantic Planning Area		17,092,000			94	2,354	383	1,919	535	2,672
	South Atlantic Planning Area		8,376,000			0	0	261	1,306	263	1,312
	Unknown Projects in Mid- and South Atlantic Planning Areas		8,000,000	N/A	N/A	34	856	209	1,045	125	626
	Mid- and South Atlantic Planning Areas		33,468,000			128	3,210	853	4,270	923	4,610

N/A = Not available.

[a] Prospecting and pre-lease HRG involves the use of subbottom profiler, side-scan sonar, bathymetry (depth sounders), and magnetometer.

[b] On-lease typically involves only a bathymetry (depth sounders).

Table A-7

Projected Levels of Geotechnical Surveys for OCS Sand Borrow Projects in the Mid- and South Atlantic Planning Areas, 2012-2020

Type of Geotechnical Sampling	Number of Deployments	Number of Samples Per Deployment	Number of Samples
Vibracoring	6-24	15-25	90-600
Geologic coring	1-4	1-2	1-8
Grab sampling	2-8	30-40	60-320

3. SPECIES AND CRITICAL HABITAT DESCRIPTIONS

Several species that are listed as endangered or threatened under the ESA may be affected by the proposed action (**Table A-8**). Under the ESA, a species is considered endangered if it is "in danger of extinction throughout all or a significant portion of its range." A species is considered threatened if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (15 U.S.C. 1532). Species currently listed as endangered or threatened include seven marine mammals, five sea turtles, three birds, and three fishes.

This analysis also includes two "candidate" fish species (alewife and blueback herring) and one "candidate" bird species (red knot). A candidate species is any species that is undergoing a status review that has been announced in a *Federal Register* notice (USDOC, NMFS, 2011a).

Critical habitat has been designated within or near the BA Area for two listed marine mammal species: the North Atlantic right whale and the Florida manatee. North Atlantic right whale critical habitat includes areas north of the BA Area (Cape Cod Bay and along the Great South Channel) and along a segment of nearshore waters within the BA Area off Georgia and northeast Florida (**Section 3.1.2.3**). Florida manatee critical habitat adjacent to the BA Area includes select inshore waterways and embayments along the northeast Florida coast (**Section 3.1.8.3**). Critical habitat for one listed bird species, the piping plover, has been designated along the coasts of North Carolina, South Carolina, Georgia, and Florida. There are no critical habitats in the BA Area or surrounding areas for listed sea turtle or fish species.

3.1. MARINE MAMMALS

3.1.1. Introduction

In the waters of the BA Area, there are 38 species of marine mammals representing three taxonomic orders: Cetacea (baleen whales, toothed whales, dolphins, and porpoises), Sirenia (manatee), and Carnivora (true seals) (Waring et al., 2010). All marine mammals are protected under the MMPA. Seven species known to occur within the BA Area are further protected under the ESA (USDOC, NMFS, 2011b). These include five baleen whales (North Atlantic right whale, blue whale, fin whale, sei whale, and humpback whale), one toothed whale (sperm whale), and the Florida subspecies of the West Indian manatee (Waring et al., 2010; USDOC, NMFS, 2011b).

The following sections provide a brief description of each listed marine mammal species, including its current status, distribution, and behavior. Marine mammal species are further identified by the MMPA stock present within the BA Area and the status of the stock. The MMPA defines the term stock as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement that interbreed when mature (50 CFR 216.3). The text and **Table A-8** also indicate the functional hearing group for each marine mammal species, based on Southall et al. (2007). Marine mammal hearing is discussed further in **Section 3.1.9**.

Table A-8

Listed and Candidate Species Considered in this Biological Assessment

Common Name	Species	MMPA Stock (and Stock Status)[1]	ESA Status[2]	Critical Habitat in or Near the BA Area	Functional Hearing Group[3]			
					L	M	H	P
MARINE MAMMALS								
Order Cetacea								
Suborder Mysticeti (Baleen Whales)								
North Atlantic right whale	*Eubalaena glacialis*	Western Atlantic (S)	E	Yes (**Fig. A-5**)	X	--	--	--
Blue whale	*Balaenoptera musculus*	Western North Atlantic (S)	E	None	X	--	--	--
Fin whale	*Balaenoptera physalus*	Western North Atlantic (S)	E	None	X	--	--	--
Sei whale	*Balaenoptera borealis*	Nova Scotia (S)	E	None	X	--	--	--
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine (S)	E	None	X	--	--	--
Suborder Odontoceti (Toothed Whales, Dolphins, and Porpoises)								
Sperm whale	*Physeter macrocephalus*	North Atlantic (S)	E	None	--	X	--	--
Order Sirenia								
West Indian manatee (Florida subspecies)	*Trichechus manatus latirostris*	Florida (S)	E	Yes (**Fig. A-10**)	--	--		X[4]
SEA TURTLES								
Loggerhead turtle	*Caretta caretta*	Not applicable	T[5]	None	X[6]	--	--	--
Green turtle	*Chelonia mydas*	Not applicable	T/E[7]	None	X[6]	--	--	--
Hawksbill turtle	*Eretmochelys imbricata*	Not applicable	E	None	X[6]	--	--	--
Kemp's ridley turtle	*Lepidochelys kempii*	Not applicable	E	None	X[6]	--	--	--
Leatherback turtle	*Dermochelys coriacea*	Not applicable	E	None	X[6]	--	--	--
BIRDS								
Roseate tern	*Sterna dougallii*	Not applicable	E	None	--	--	--	--
Bermuda petrel	*Pterodroma cahow*	Not applicable	E	None	--	--	--	--
Piping plover	*Charadrius melodus*	Not applicable	T	None	--	--	--	--
Red knot	*Calidris canutus*	Not applicable	C	None	--	--	--	--
FISHES								
Smalltooth sawfish	*Pristis pectinata*	Not applicable	E	None	--	--	--	--
Shortnose sturgeon	*Acipenser brevirostrum*	Not applicable	E	None	--	--	--	--
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Not applicable	E/T[8]	None	--	--	--	--
Alewife	*Alosa pseudoharengus*	Not applicable	C	None	--	--	--	--
Blueback herring	*Alosa aestivalis*	Not applicable	C	None	--	--	--	--

[1] MMPA = Marine Mammal Protection Act (S = strategic stock).
[2] ESA = Endangered Species Act (E = endangered; T = threatened; C = candidate).
[3] Functional marine mammal hearing groups and specific auditory ranges (Adapted from Southall et al. 2007). L = Low-Frequency Cetacean (7 Hz-22 kHz); M = Mid-Frequency Cetacean (150 Hz-160 kHz); H = High-Frequency Cetacean (200 Hz-180 kHz); P = Pinniped In Water (75 Hz-75 kHz).
[4] Manatee hearing is not addressed by Southall et al. (2007). Based on review of marine mammal hearing, manatee hearing is similar to that of phocid pinnipeds except at the lowest frequencies.
[5] The Northwest Atlantic Distinct Population Segment (DPS) of the loggerhead turtle is currently listed as threatened (*Federal Register*, 2011c).
[6] Hearing capabilities of sea turtles are not well documented. Sea turtles appear to be low frequency specialists, with best hearing projected to occur within the frequency range of 50-1,000 Hz.
[7] The green turtle is threatened, except for the Florida breeding population, which is endangered (USDOC, NMFS, 2011c).
[8] Five DPSs of Atlantic sturgeon have been listed under the ESA (*Federal Register*, 2012b,c). The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered and could be represented within the BA area. The Gulf of Maine DPS is listed as threatened and is not likely to be present in the BA area.

Sources: Southall et al. (2007); Waring et al. (2010).

3.1.2. North Atlantic Right Whale (*Eubalaena glacialis*)

3.1.2.1. Species Overview

The North Atlantic right whale is the only member of the family Balaenidae found in North Atlantic waters. It is medium in size when compared to other baleen whale species, with adult size ranging from 14-17 m (45-55 ft) (USDOC, NMFS, 2005). Females are larger than males. Right whales may be distinguished from other baleen whale species by their black color and stocky body; large head size with a strongly bowed lower jaw; thickened, light-colored patches of epidermis called callosities; the absence of a dorsal fin; and short, broad, paddle-shaped flippers (Jefferson et al., 2008).

The North Atlantic right whale is usually found within waters of the western North Atlantic between 20° and 60° N latitude. Generally, individual right whales undergo seasonal coastal migrations from summer feeding grounds off eastern Canada and the U.S. northeast coast to winter calving grounds off the U.S. southeast coast (**Figure A-4**). Recent sightings data also show that a few North Atlantic right whales range as far as Newfoundland, the Labrador Basin, and southeast of Greenland (Waring et al., 2010). Research results suggest the existence of six major congregation areas for North Atlantic right whales: the coastal waters of the southeastern U.S., the Great South Channel, Georges Bank/Gulf of Maine, Cape Cod and Massachusetts Bays, the Bay of Fundy, and the Scotian Shelf (Waring et al., 2010). Movements of individuals within and between these congregation areas are extensive, and data show distant excursions, including into deep water off the continental shelf (Mate et al., 1997; Baumgartner and Mate, 2005).

North Atlantic right whales are usually observed in groups of less than 12 individuals, and most often as single individuals or pairs. Larger groups may be observed in feeding or breeding areas (Jefferson et al., 2008). Right whales feed on zooplankton (e.g., calanoid copepods) generally by skimming through concentrated patches of prey at or below the sea surface. Grouping of individual right whales within their congregation areas is likely to be a function of acceptable prey distribution, since right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx, 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney et al., 1986, 1995).

The typical reproductive cycle in mature female right whales is 3 years between births. The age at sexual maturity is estimated at 9 or 10 years, and gestation length is about 12 months; calves nurse for almost 12 months.

Threats to the North Atlantic right whale population within the BA Area include commercial fishing interactions, vessel strikes, underwater noise, habitat degradation, and predators (USDOC, NMFS, 2005; Waring et al., 2010). Ship collisions and fishing gear entanglements are the most common anthropogenic causes of mortality in western North Atlantic right whales, judging from observations of stranded animals (USDOC, NMFS, 2005).

Of 45 confirmed deaths of western North Atlantic right whales between 1970 and 1999, 16 are known to have been caused by ship strikes, and two additional collisions were judged as possibly fatal (Knowlton and Kraus, 2001). There were two known ship strike right whale deaths in 2001, one in 2002, one in 2003, and two in 2004 (USDOC, NMFS, 2005). According to Waring et al. (2010), for the period 2004 through 2008, the minimum rate of annual mortality and serious injury to right whales from ship strikes averaged 2.0 per year.

Kraus (1990) estimated that 57 percent of right whales in the western North Atlantic bear scars and injuries indicating fishing gear entanglement; the figure was revised to 61.6 percent by more recent analysis (Hamilton et al., 1998). Sources of interaction mainly lie with gillnets, lobster pots, seine nets, and fish weirs, which, with the exception of gillnet fisheries, are largely not monitored (USDOC, NMFS, 2005). According to Waring et al. (2010), for the period 2004 through 2008, the minimum rate of annual mortality and serious injury to right whales due to fishery entanglement averaged 0.8 per year.

The North Atlantic right whale is considered to fall within the low-frequency cetacean functional hearing group (Southall et al., 2007).

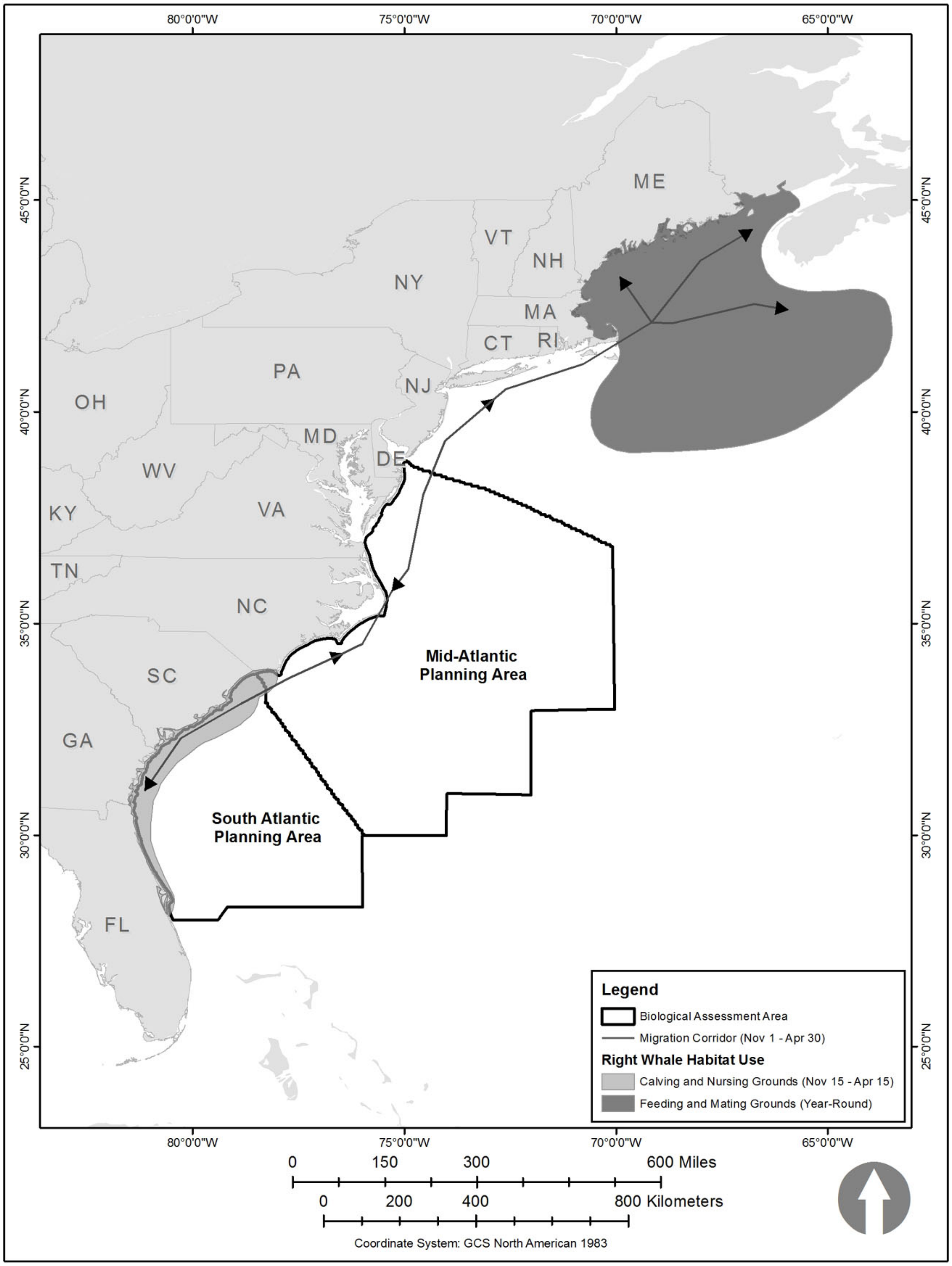


Figure A-4. North Atlantic Right Whale Seasonal Distribution and Habitat Use. Source: NMFS Southeast Regional Office, St. Petersburg, Florida (http://sero.nmfs.noaa.gov).

3.1.2.2. Presence and Abundance within the Biological Assessment Area

The North Atlantic right whale is considered one of the most critically endangered whales (Jefferson et al., 2008). It is listed as endangered under the ESA, and the western Atlantic stock is classified as strategic because the average annual human-related mortality and serious injury exceeds the Potential Biological Removal (PBR) level (Waring et al., 2010). The minimum population size is estimated at approximately 361 individuals (Waring et al., 2010).

North Atlantic right whales undergo seasonal coastal migrations from summer feeding grounds off eastern Canada and the U.S. northeast coast to winter calving grounds off the U.S. southeast coast (**Figure A-4**). The winter calving grounds and a segment of the migratory corridor are located within the BA Area. Most calving takes place in shallow coastal waters offshore Georgia and Florida between December and March (USDOC, NMFS, 2005). Some mother-calf pairs may use the area from Cape Fear, North Carolina, to South Carolina as a wintering/calving area as well (USDOC, NMFS, 2005). Although the main feeding grounds are located offshore Canada and the northeastern U.S., right whales may also feed, at least opportunistically, while migrating. Waters offshore the Mid-Atlantic states have not been considered to include "high use" areas, yet the whales clearly move through these waters regularly. The seasonal movements of the North Atlantic right whale among congregation areas and within the BA Area are still poorly understood. Data suggest that not all reproductively active females return to calving and nursery grounds each year, and additional wintering and summering grounds may exist in unsurveyed locations of the western North Atlantic (Waring et al., 2010).

3.1.2.3. Critical Habitat

In 1994, three critical habitats for the North Atlantic right whale were designated by NMFS along the eastern coast of the U.S. (*Federal Register*, 1994). These include Cape Cod Bay/Massachusetts Bay, the Great South Channel, and selected areas off the southeastern U.S. (**Figure A-5**). In 2009, NMFS received a petition to expand the critical habitat to include the U.S. waters of the entire Gulf of Maine, and the agency is continuing its ongoing rulemaking process for revisions to the critical habitat rule (*Federal Register*, 2010c; M. Minton, NMFS Northeast Regional Office, pers. comm. to S. Viada, CSA International, Inc., April 3, 2012). The NMFS has also initiated a 5-year status review of North Atlantic and North Pacific right whales (*Federal Register*, 2012a).

In addition to critical habitat, Seasonal Management Areas (SMAs) for right whales have been designated to reduce ship strikes (**Figure A-5**). All vessels greater than 19.8 m (65 ft) in overall length must operate at speeds of 10 kn or less within these areas during specific time periods (**Table A-9**) (USDOC, NOAA, 2011).

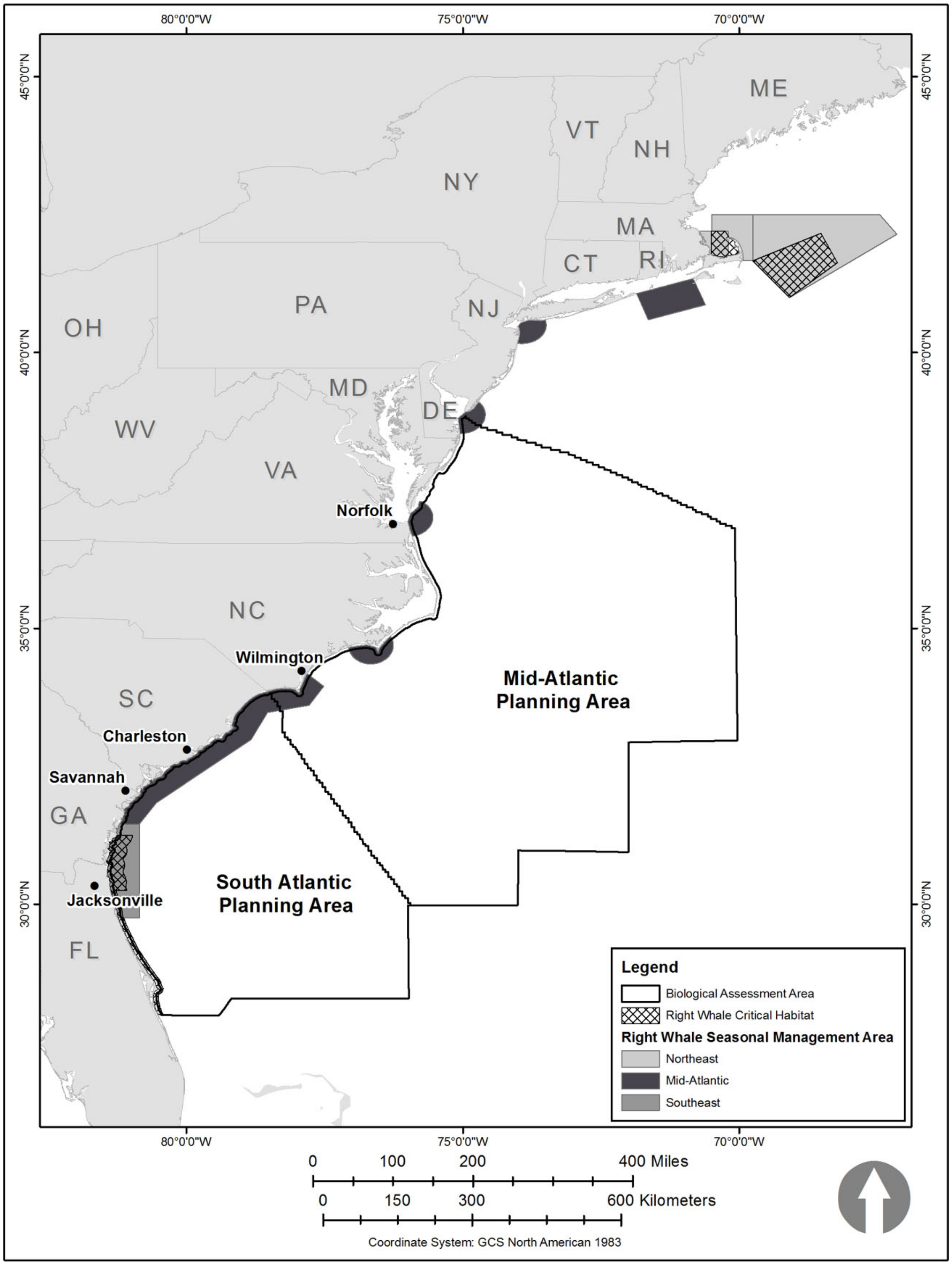


Figure A-5. North Atlantic Right Whale Critical Habitat and Seasonal Management Areas. Source: 50 CFR 224.105.

Table A-9

Designated U.S. and Canadian Seasonal Management Areas for the North Atlantic Right Whale

Regional Area	Individual Areas	Concerns	Period of Activity
Northeast U.S. Seasonal Management Areas	Cape Cod Bay	Feeding Area	January 1–May 15
	Off Race Point	Feeding Area	March 1–April 30
	Great South Channel	Feeding Area	April 1–July 31
Mid-Atlantic U.S. Seasonal Management Areas	Block Island Sound	Migratory Route and Calving Grounds	November 1–April 30
	Ports of New York/ New Jersey		
	Entrance to Delaware Bay		
	Entrance to Chesapeake Bay		
	Ports of Morehead City and Beaufort, NC		
	Wilmington, NC to Brunswick, GA		
Southeast U.S. Seasonal Management Area	Central GA to northeast FL	Calving and Nursery Grounds	November 15–April 15
Grand Manan Basin Critical Habitat Area	New Brunswick and Nova Scotia, Canada	Feeding Area	June–December
Roseway Basin Critical Habitat Area	South of Nova Scotia, Canada	Feeding Area	

3.1.3. Blue Whale (*Balaenoptera musculus*)

3.1.3.1. Species Overview

The blue whale is the largest cetacean, although its size range overlaps with that of fin and sei whales. The northern hemisphere subspecies (*B. m. musculus*) is known to occur within the BA Area. Most adults of this subspecies are 23-27 m (75-90 ft) in length. The blue whale, other balaenopterid whales, and the humpback whale are constituents of the rorqual baleen whale group. Species within this group possess a number of modifications of the cervico-thoracic region that enable them to engulf large volumes of water to filter for prey. The most conspicuous of these modifications is a series of longitudinal folds or corrugations of skin running from below the mouth back toward the navel (Lambertsen, 1983).

Blue whales are usually observed alone or in pairs (Jefferson et al., 2008). Scattered aggregations may develop on prime feeding grounds in the Gulf of St. Lawrence offshore Canada. Their diet consists primarily of krill (euphausiids), and their depth distribution is usually associated with feeding (Sears, 2002). Blue whales reach sexual maturity at 5-15 years, and mating in the northern hemisphere occurs in late fall and throughout the winter, although no specific breeding ground has been discovered (Sears, 2002). In general, the blue whale's range and seasonal distribution is governed by the availability of prey and open water for feeding (USDOC, NMFS, 1998a).

Threats for North Atlantic blue whales are poorly known but may include ship strikes, pollution, entanglement in fishing gear, and long-term changes in climate (which could affect the abundance of their prey) (USDOC, NMFS, 1998a). There are no recent confirmed records of mortality or serious injury to blue whales in the BA Area. However, in March 1998 a dead 20-m (66-ft) male blue whale was brought into Rhode Island waters on the bow of a tanker. The cause of death was determined to be ship strike. At least one blue whale found dead in the Gulf of St. Lawrence in recent years apparently died from the effects of entanglement in fishing gear (USDOC, NMFS, 1998a). The lack of more evidence that blue whales become entrapped or entangled in fishing gear in the western North Atlantic may be due to incomplete reporting. In addition, the large size of the animals makes it more likely that blue whales will break through nets or carry gear away with them. In the latter case, undetected mortality may result from starvation due to interference with feeding, as sometimes occurs in humpback and North Atlantic right whales.

Blue whales are categorized within the low-frequency cetacean functional hearing group (7 Hz-22 kHz) (Southall et al., 2007).

3.1.3.2. Presence and Abundance within the Biological Assessment Area

The blue whale is considered by the NMFS as an occasional visitor in U.S. Atlantic EEZ waters, which may represent the current southern limit of its feeding range (Waring et al., 2010). In the western North Atlantic Ocean, the blue whale's range extends from the Arctic to Cape Cod, Massachusetts, although it is frequently sighted off eastern Canada (e.g., Newfoundland) (Waring et al., 2010). Yochem and Leatherwood (1985) report an occurrence of this species as far south as Florida and the Gulf of Mexico, although sightings within these areas and the BA Area are considered uncommon or rare.

The northern hemisphere subspecies of the blue whale is listed as an endangered species. Animals in the western North Atlantic are placed within the Western North Atlantic stock, which is classified as strategic because the species is listed as endangered under the ESA (Waring et al., 2010). The NMFS has not developed a stock size estimate for the Western North Atlantic blue whale stock (Waring et al., 2010). Currently, the number of blue whales in the North Atlantic Ocean is estimated at approximately 1,000 individuals (International Whaling Commission, 2011a).

3.1.3.3. Critical Habitat

There is no designated critical habitat for blue whales within the western North Atlantic, including waters of the BA Area.

3.1.4. Fin Whale (*Balaenoptera physalus*)

3.1.4.1. Species Overview

The fin whale is the second largest species of whale (USDOC, NMFS, 2010a). Some authors recognize separate northern and southern hemisphere subspecies, although this designation is not widely accepted (Jefferson et al., 2008). Adult fin whales in the northern hemisphere may reach a length of approximately 24 m (80 ft).

Fin whales are observed singly or in groups of 2-7 individuals. In the North Atlantic, fin whales are often seen in large mixed-species feeding aggregations including humpback whales, minke whales, and Atlantic white-sided dolphins (Jefferson et al., 2008). Fin whales feed on zooplankton (euphausiids and copepods); small schooling fishes such as capelin, herring, mackerel, sandlance, and blue whiting; and squids (Jefferson et al., 2008). The USDOC, NMFS (2010a) reports summer feeding grounds mostly between 41°20' and 51°00' N latitude (shore to 1,829 m [6,000 ft]). 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.

Fin whales are categorized within the low-frequency cetacean functional hearing group (Southall et al., 2007).

3.1.4.2. Presence and Abundance within the Biological Assessment Area

The fin whale is found primarily within temperate and polar latitudes (**Figure A-6**). Seasonal migration patterns within its range remain undetermined (Waring et al., 2010). The fin whale was, however, the most common whale species sighted in northwest Atlantic waters from Cape Hatteras, North Carolina, to Maine during surveys conducted from 1978 through 1982, with fin whales representing 46 percent of all sightings (USDOC, NMFS, 2010a; Waring et al., 2010).

Fin whales off the eastern U.S. and eastern Canada are believed to constitute a single stock (Western North Atlantic stock) under the present International Whaling Commission scheme (Waring et al., 2010). The species is currently listed as endangered under the ESA. The Western North Atlantic stock is classified as strategic because of its listing under the ESA. The current estimated population size of this stock is 3,985 individuals (Waring et al., 2010).

3.1.4.3. Critical Habitat

There is no designated critical habitat for the fin whale (USDOC, NMFS, 2010a).

3.1.5. Sei Whale (*Balaenoptera borealis*)

3.1.5.1. Species Description and Status

The sei whale is the third largest whale (following the blue and fin whales), with adult lengths ranging from 16-20 m (52-66 ft). It is very similar in appearance to fin and Bryde's whales.

There are two suggested sei whale stocks within the northwest Atlantic: the Nova Scotia stock and the Labrador Sea stock. Differentation of these two stocks is problematic, but Waring et al. (2010) provisionally adopted the Nova Scotia stock definition to represent all sei whales within the BA Area (Waring et al., 2010). The range of the Nova Scotia stock includes the continental shelf waters of the northeastern U.S. and extends northeastward to south of Newfoundland.

The sei whale is currently listed as endangered under the ESA. The Nova Scotia stock is classified as strategic because of its listing under the ESA.

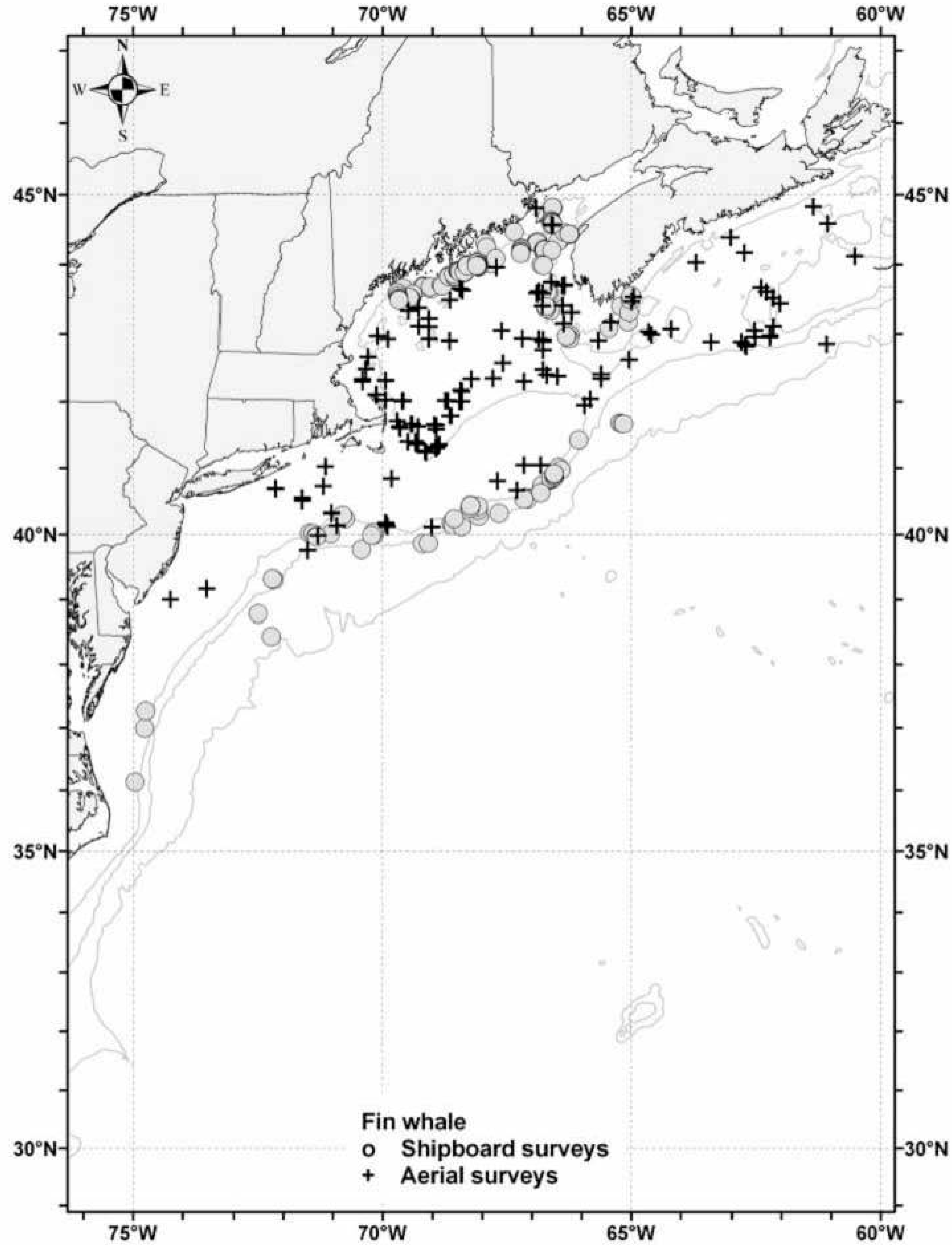


Figure A-6. Distribution of Fin Whale Sightings from Northeast Fisheries Science Center and Southeast Fisheries Science Center Shipboard and Aerial Surveys during Summer 1998, 1999, 2002, 2004, 2006, and 2007. Isobaths are the 100-m (328-ft), 1,000-m (3,280-ft), and 4,000-m (13,124-ft) Depth Contours. Source: Waring et al. (2010).

Sei whales are largely planktivorous, feeding primarily on euphausiids and copepods, but they will feed on small schooling fishes as well (Jefferson et al., 2008; Waring et al., 2010). Similar to right whales, they generally skim copepods, though they will lunge and gulp on occasion like other rorqual species. Groups of two to five individuals are most commonly seen. Calving occurs in midwinter within the low latitude portions of the species' range (Jefferson et al., 2008). Specific breeding and calving areas have not been identified.

Sei whales are categorized within the low-frequency cetacean functional hearing group (Southall et al., 2007).

3.1.5.2. Presence and Abundance within the Biological Assessment Area

The sei whale is a cosmopolitan and highly migratory species that is found from temperate to subpolar regions, but it appears to be more restricted to mid-latitude temperate zones than other rorquals (*Balaenoptera* and *Megaptera novaeangliae*) (Reeves et al., 2002; Shirihai and Jarrett, 2006; Jefferson et al., 2008). Sei whales are commonly sighted off Nova Scotia, the Gulf of Maine, and Georges Bank in spring and summer (Waring et al., 2010). Data suggest a major portion of the Nova Scotia stock is centered in waters north of the BA Area, at least during the feeding season (Waring et al., 2010). Within this range, the sei whale is often found near the continental shelf edge region. This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters (**Figure A-7**). There is no current population estimate of sei whales in the western North Atlantic Ocean, though survey data suggest that the Nova Scotia stock size is around 386 individuals (Waring et al., 2010).

3.1.5.3. Critical Habitat

There is no designated critical habitat for the sei whale (Waring et al., 2010).

3.1.6. Humpback Whale (*Megaptera novaeangliae*)

3.1.6.1. Species Overview

The humpback whale is medium in size, and adults range from 15-18 m (50-60 ft) in length. The body is more robust than other rorqual whales, and they are distinguished from all other large whale species by their long flippers, which are approximately one-third the length of the body.

Distinct geographic forms of humpback whales are not widely recognized, though genetic evidence suggests there are several subspecies (e.g., North Atlantic, Southern Hemisphere, and North Pacific subspecies) (USDOC, NMFS, 1991; Waring et al., 2010). In 2000, the NMFS Atlantic Stock Assessment Team reclassified western North Atlantic humpback whales as a separate and discrete management stock (Gulf of Maine stock) (Waring et al., 2010). The current population estimate of the Gulf of Maine stock is 847 individuals (Waring et al., 2010).

The humpback whale is currently listed as endangered under the ESA. The Gulf of Maine stock is classified as strategic because of its listing under the ESA.

Humpback whales feed on krill and small schooling fishes (Jefferson et al., 2008). In New England waters, humpback whales prey upon herring, sand lance, and euphausiids (Paquet et al., 1997). Humpback whales use unique behaviors, such as bubble nets, bubble clouds, and flickering their flukes and flippers, to herd and capture prey (USDOC, NMFS, 1991). They are also one of the few species of baleen whales to utilize cooperative feeding techniques. The age at sexual maturity is between 4 and 6 years (USDOC, NMFS, 1991), and the gestation length is 11 months; calves are nursed for 6-10 months.

Humpback whales are categorized within the low-frequency cetacean functional hearing group (Southall et al., 2007).

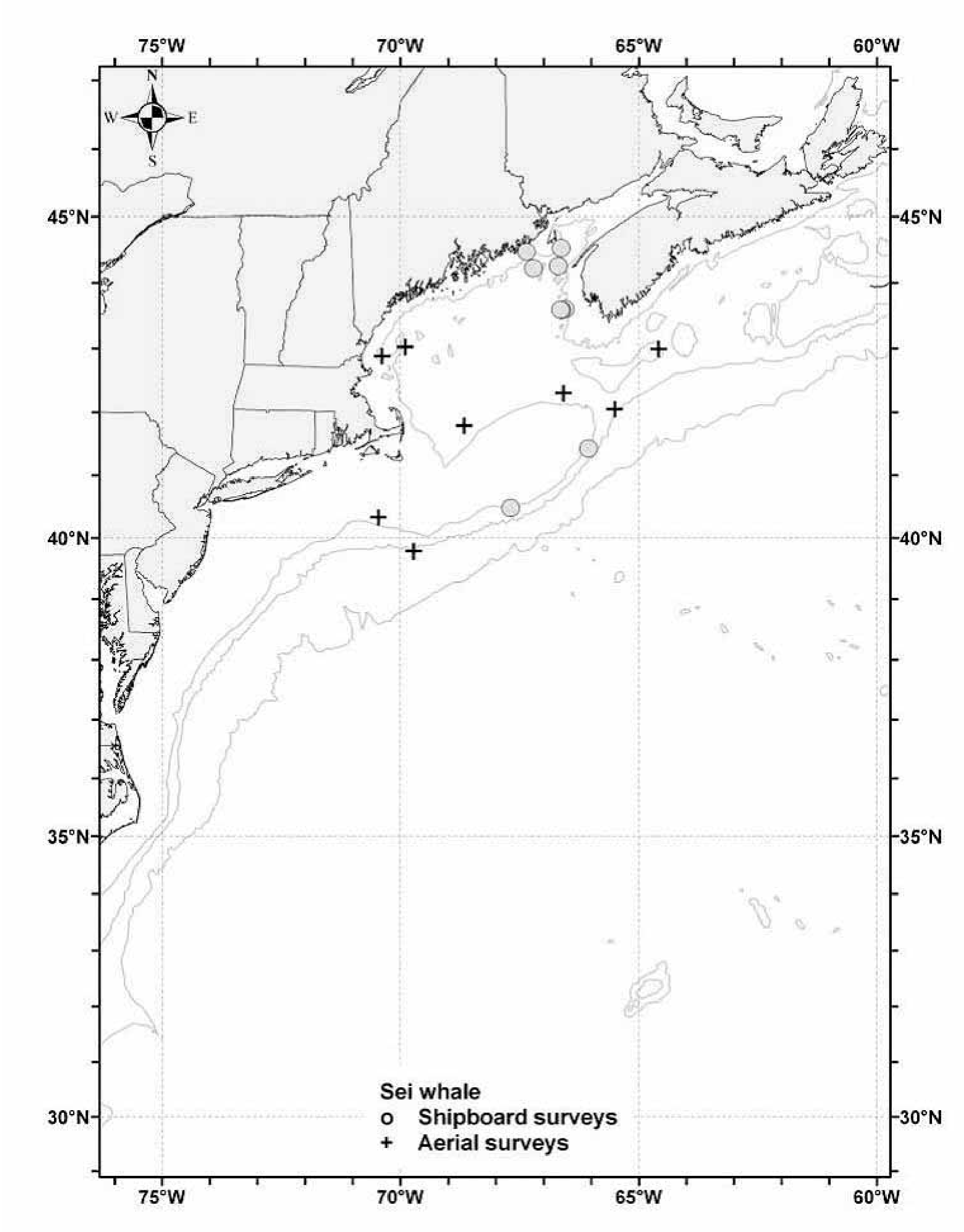


Figure A-7. Distribution of Sei Whale Sightings from Northeast Fisheries Science Center and Southeast Fisheries Science Center Shipboard and Aerial Surveys during Summer 1998, 1999, 2002, 2004, 2006, and 2007. Isobaths are the 100-m (328-ft), 1,000-m (3,280-ft), and 4,000-m (13,124-ft) Depth Contours. Source: Waring et al. (2010).

3.1.6.2. Presence and Abundance within the Biological Assessment Area

The humpback whale is a cosmopolitan species that may be found from the equator to subpolar latitudes (less common in the Arctic). Some individuals are found year-around at certain locations (e.g., Gulf of Maine), while others display highly migratory patterns. Humpback whales are generally found within continental shelf areas and oceanic islands. Most humpback whales in the western North Atlantic Ocean migrate to the West Indies (e.g., Dominican Republic) to mate; however, some whales do not make the annual winter migration (Waring et al., 2010). Sightings data show that humpback whales traverse coastal waters of the southeastern U.S., including the BA Area (Waring et al., 2010) (**Figure A-8**).

Swingle et al. (1993) and Barco et al. (2002) reported humpback sightings off Delaware Bay and Chesapeake Bay during the winter, which suggests the Mid-Atlantic region may also serve as wintering grounds for some Atlantic humpback whales. This region has also been suggested as an important area for juvenile humpbacks (Wiley et al., 1995).

3.1.6.3. Critical Habitat

No critical habitat has been designated for the humpback whale.

3.1.7. Sperm Whale (*Physeter macrocephalus*)

3.1.7.1. Species Overview

The sperm whale is the largest toothed cetacean, with adult lengths ranging from 12-18 m (40-60 ft). They are also the most sexually dimorphic whale in body length and weight (Whitehead, 2002). The most distinctive feature of the sperm whale is a massive and specialized nasal complex.

Sperm whales within the northern Atlantic are classified in one stock (North Atlantic stock). It remains unresolved whether the northwestern Atlantic population is discrete from the northeastern Atlantic population (Waring et al., 2010). The current population estimate of the North Atlantic stock is 4,804 individuals (Waring et al., 2010).

The sperm whale is currently listed as endangered under the ESA. The Northern Atlantic stock is classified as strategic because of its listing under the ESA.

Sperm whales are cosmopolitan in their distribution, ranging from tropical latitudes to pack ice edges in both hemispheres (Jefferson et al., 2008). Generally, only male sperm whales venture to the extreme low latitudes. Sperm whales are usually found in medium to large "family unit" groups of 20-30 females and their young. Young males leave their natal unit group at an age of 4-21 years and form loose aggregations called "bachelor schools" with other males of approximately the same age. Older males are usually solitary (Whitehead, 2002). Sperm whales feed primarily on cephalopods (squids and octopuses) and demersal and mesopelagic fishes (Whitehead, 2002; Jefferson et al., 2008; USDOC, NMFS, 2010b). The age at sexual maturity is much older than for most whales; age of sexual maturity is between 7-13 years for females and in the twenties for males (USDOC, NMFS, 2010b). Their gestation length is between 12-15 months, and lactation extends almost 2 years. The lifespan has been estimated to be 60 years or more (Rice, 1989).

Sperm whales are categorized within the mid-frequency cetacean functional hearing group (Southall et al., 2007).

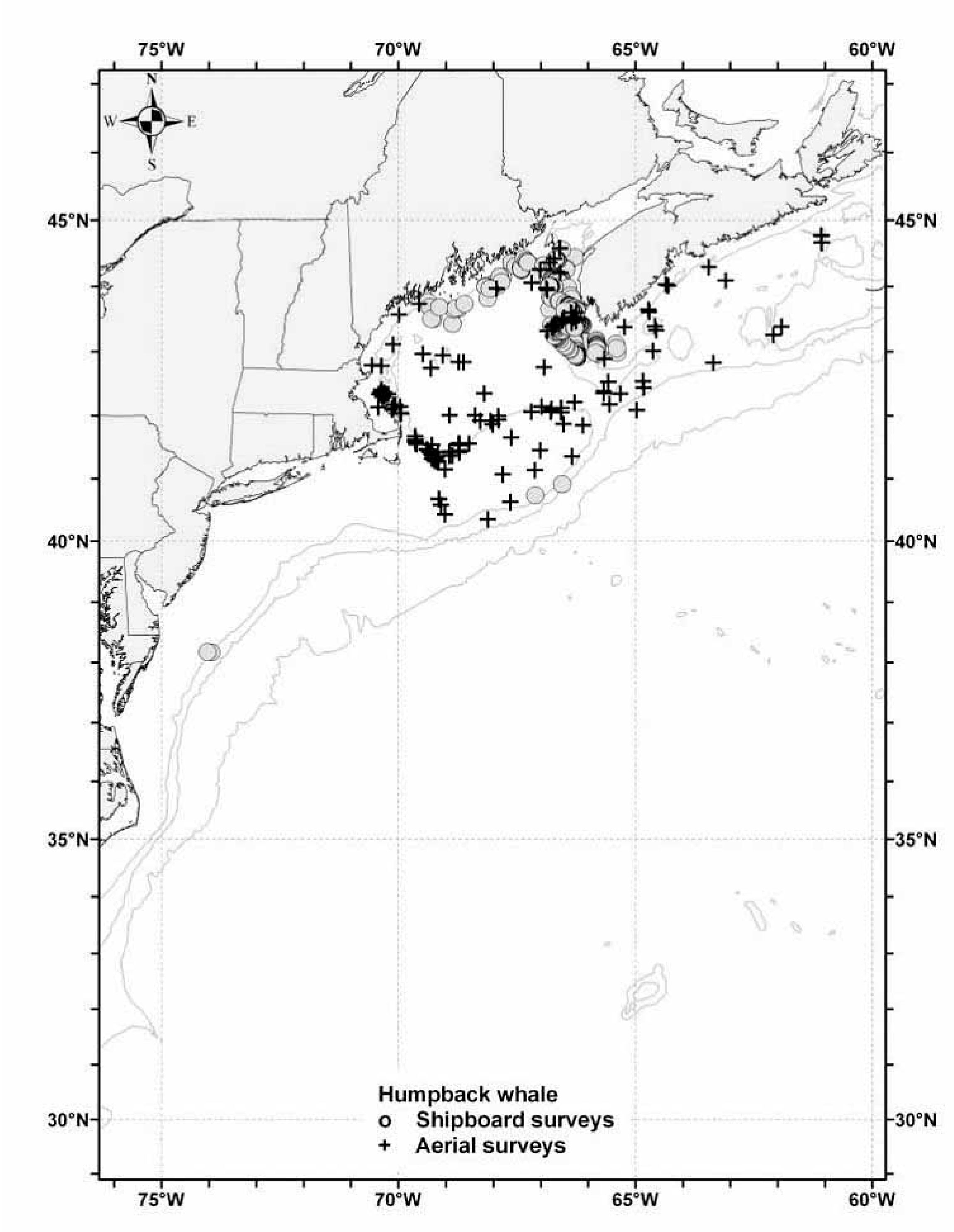


Figure A-8. Distribution of Humpback Whale Sightings from Northeast Fisheries Science Center and Southeast Fisheries Science Center Shipboard and Aerial Surveys during Summer 1998, 1999, 2002, 2004, 2006, and 2007. Isobaths are the 100-m (328-ft), 1,000-m (3,280-ft), and 4,000-m (13,124-ft) Depth Contours. Source: Waring et al. (2010).

3.1.7.2. Presence and Abundance within the Biological Assessment Area

In the western North Atlantic, there appears to be a distinct seasonal distribution pattern (Waring et al., 2010). In winter, sperm whales concentrate east and northeast of Cape Hatteras. In spring, the distribution center moves northward to waters east of Delaware and Virginia but spreads throughout the central portion of the Mid-Atlantic Bight to the southern portion of Georges Bank. In summer, the distribution also includes continental slope and shelf waters as far as southern New England (**Figure A-9**). In the fall, sperm whale occurrence on the continental shelf and shelf edge is highest in the Mid-Atlantic Bight.

According to Waring et al. (2010), the current sperm whale population estimate for the western North Atlantic (U.S. east coast) is 4,804 individuals. This estimate includes 2,697 individuals for the northern U.S. Atlantic and 2,197 individuals for the southern U.S. Atlantic.

3.1.7.3. Critical Habitat

There is no critical habitat for the sperm whale (USDOC, NMFS, 2010b).

3.1.8. Florida Manatee (*Trichechus manatus latirostris*)

3.1.8.1. Species Overview

The Florida subspecies of the West Indian manatee is the only sirenian that occurs along the eastern coast of the U.S. The average adult West Indian manatee ranges from 3-4 m (10-13 ft) in length and between 362 and 544 kg (800 and 1,200 lb) in weight (USDOI, FWS, 2001, 2007).

The Florida manatee is currently listed as endangered under the ESA and a “strategic stock” under the MMPA. The species is also protected under the Florida Manatee Sanctuary Act. The majority of the Atlantic population of the Florida manatee is located in eastern Florida and southern Georgia (Waring et al., 2010) and managed within four distinct regional management units: Atlantic Coast (northeast Florida to the Florida Keys), Upper St. Johns River (St. Johns River, south of Palakta), Northwest (Florida Panhandle to Hernando County), and Southwest (Pasco County to Monroe County) (USDOI, FWS, 2001, 2007). The Atlantic Coast unit is the most relevant to the BA Area.

Manatees are herbivorous, feeding on a wide array of aquatic (freshwater and marine) plants such as water hyacinths and marine seagrasses. They generally prefer shallow seagrass beds, especially areas with access to deep channels. Preferred coastal and riverine habitats (e.g., near the mouths of coastal rivers) are also used for resting, mating, and calving (USDOI, FWS, 2001, 2007).

Manatee hearing is discussed in **Section 3.1.9.3**. The data suggest that manatees have hearing capabilities that are generally similar to phocid pinnipeds, with functional hearing between about 250 Hz and ~90 kHz.

3.1.8.2. Presence and Abundance within the Biological Assessment Area

Within the northwestern Atlantic, manatees occur in coastal marine, brackish, and freshwater areas from Florida to Virginia, with occasional extralimital sightings as far north as Rhode Island (Jefferson et al., 2008). Because they have little tolerance for cold, they are generally restricted to inland and coastal waters of peninsular Florida during the winter, where they shelter in or near sources of warm water (springs, industrial effluents, and other warm-water sites) (Waring et al., 2010). The Atlantic Coast regional management unit is the most relevant to the BA Area. The best population estimate of Florida manatees is 3,802 individuals (Waring et al., 2010).

3.1.8.3. Critical Habitat

Critical habitat was designated for the Florida manatee on September 24, 1976 (*Federal Register*, 1976) and includes inland waterways in four northeastern Florida coastal counties (Brevard, Duval, St. Johns, and Nassau) adjacent to the BA Area (**Figure A-10**).

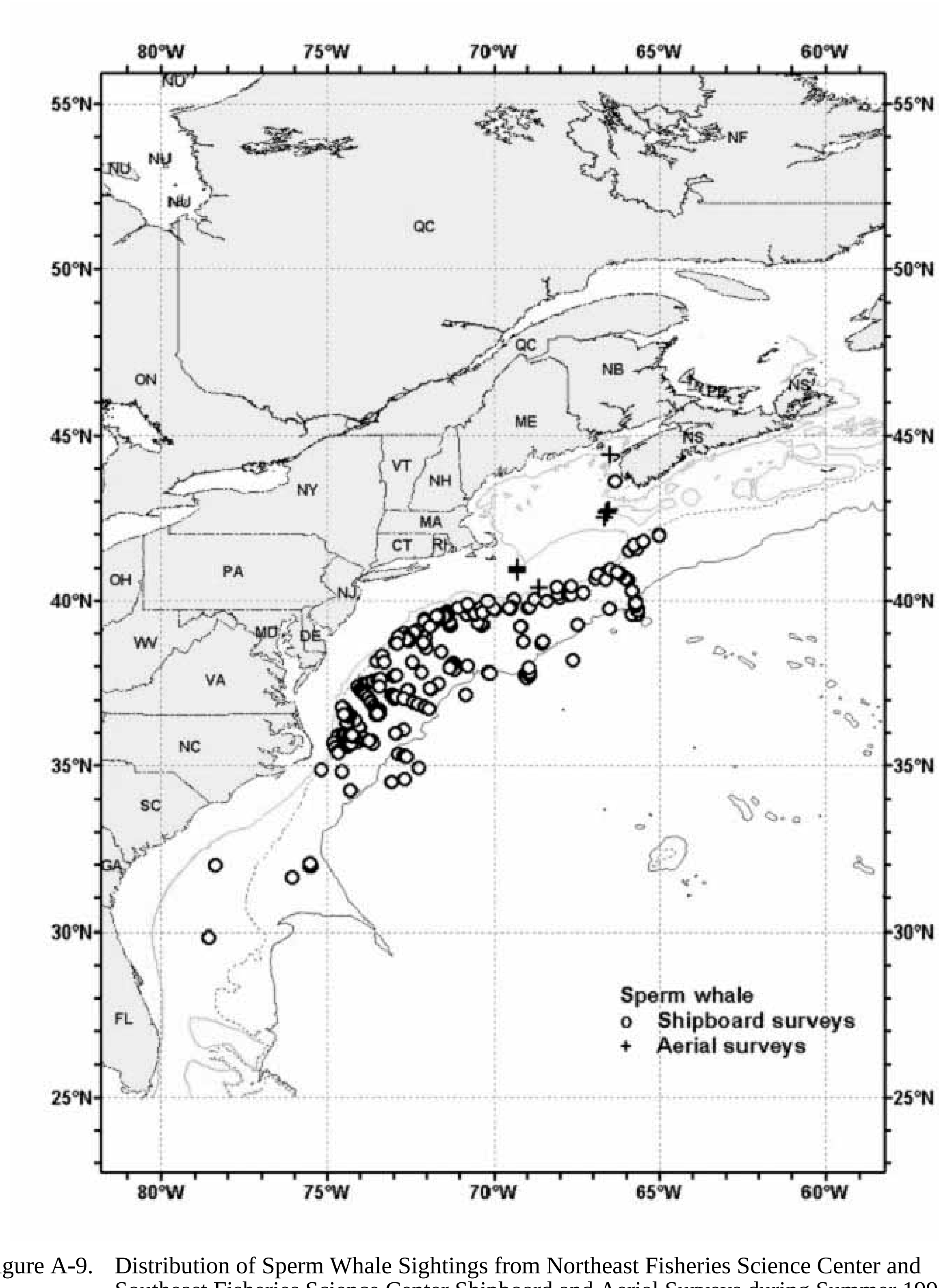


Figure A-9. Distribution of Sperm Whale Sightings from Northeast Fisheries Science Center and Southeast Fisheries Science Center Shipboard and Aerial Surveys during Summer 1998, 1999, 2002, 2004, and 2006. Isobaths are the 100-m (328-ft), 1,000-m (3,280-ft), and 4,000-m (13,124-ft) Depth Contours. Source: Waring et al. (2010).

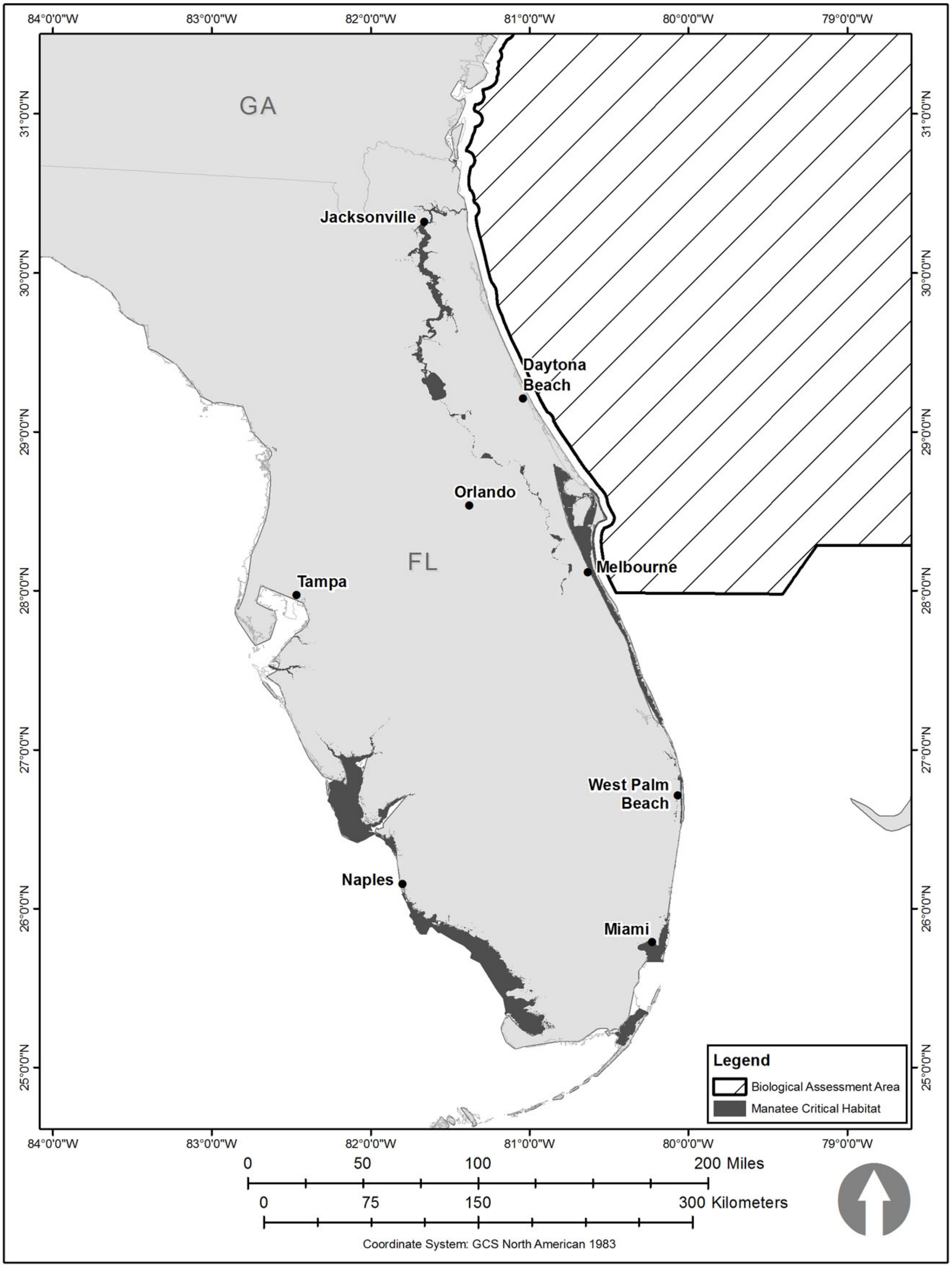


Figure A-10. Florida Manatee Critical Habitat. Source: 50 CFR 17.95.

3.1.9. Marine Mammal Hearing Capabilities

Hearing has been measured using behavioral and/or electrophysiological methods in about a quarter of the known marine mammal species, although with a disproportional representation of species commonly found in captivity, and some entire groups (e.g., mysticete cetaceans) remain untested. For a detailed review, see Southall et al. (2007); key findings obtained since then are discussed in **Appendix H** of the Draft Programmatic EIS and summarized below. Hearing sensitivity is generally quantified by determining the quietest possible sound that is detectable by an animal (either via a behavioral response or by quantifying an electrical response) on some signal presentations. By testing such responses across a range of test frequencies, a measure of the animal's overall hearing capability (typically called an "audiogram") may be obtained.

3.1.9.1. Hearing in Mysticete Cetaceans

Because of the lack of captive subjects and logistical challenges of bringing experimental subjects into the laboratory, direct measurements of mysticete hearing are unavailable, although there was an unsuccessful attempt to directly measure hearing in a stranded gray whale calf by Ridgway and Carder (2001). Consequently, hearing in mysticetes is estimated based on other means such as vocalizations (Wartzok and Ketten, 1999), anatomy (Houser et al., 2001; Parks et al., 2007), behavioral responses to sound (Frankel, 2005; Reichmuth, 2007), and nominal natural background noise conditions in the likely frequency ranges of hearing (Clark and Ellison, 2004).

The combined information from these and other sources strongly suggests that mysticetes are likely most sensitive to sound from perhaps tens of hertz to ~10 kHz. However, humpback whales (*Megaptera novaeangliae*) produce sounds with harmonics extending above 24 kHz (Au et al., 2006), and Ketten et al. (2007) suggested, based on anatomical data, that some mysticetes could hear frequencies up to 30 kHz. Southall et al. (2007) estimated the lower and upper frequencies for functional hearing in mysticetes, collectively, to be 7 Hz and 22 kHz, respectively, but based on the above information this may be a slight underestimate on the high-frequency cutoff. Nevertheless, there appears to be little doubt that mysticetes operate primarily in the very low and low frequency ranges.

3.1.9.2. Hearing in Odontocete Cetaceans

Because of the presence of specialized, high-frequency biosonar and lower frequency communication systems in odontocete cetaceans, it is almost certain that they hear over an extremely wide frequency range, spanning some 12 octaves in some species. Hearing has been directly measured in controlled conditions for over a dozen odontocete species with either behavioral or electrophysiological techniques. Southall et al. (2007) reviewed the available literature and (like Wartzok and Ketten, 1999) identified two functional hearing groups within the odontocetes, which they referred to as mid-frequency cetaceans (with functional hearing between 150 Hz and 160 kHz) and high-frequency specialists (functional hearing estimated between 200 Hz and 180 kHz). Subsequent to the Southall et al. (2007) publication, additional data have been obtained on several species that had been previously tested (such as harbor porpoise) and measurements or anatomical modeling results have been obtained for several new species – e.g., Cuvier's beaked whales (Cranford et al., 2008a,b) and false killer whales (Montie et al., 2011) suggesting that these additional species have basic hearing ranges and functional capabilities similar to those of other cetaceans. These and other studies have contributed to an increased understanding of hearing in odontocete cetaceans, but they are fundamentally consistent with the Southall et al. (2007) assessment for these species in terms of the broad range and high-frequency extension of functional hearing in odontocete cetaceans.

3.1.9.3. Hearing in Pinnipeds and Manatees

There are no listed pinnipeds occurring in the BA Area. Pinnipeds are amphibious mammals and have functional hearing both above and below the water, although they have broader functional hearing ranges in water (see Kastak and Schusterman, 1998 for a discussion). Direct measurements of hearing using behavioral and electrophysiological methods have been obtained in nearly 10 different species (Southall et al., 2007; Mulsow and Reichmuth, 2010). Southall et al. (2007) estimated functional hearing across all pinnipeds as extending between 75 Hz and 75 kHz under water and between 75 Hz and 30 kHz in air. However, they also noted that, as in the odontocete cetaceans, there appears to be a segregation in functional hearing within pinniped taxa, with phocids (seals lacking external ear pinnae that are less mobile on land, such as harbor seals) extending to much higher frequencies, especially in water, than otariids (seal lions and fur seals that have distinct external ear pinnae and are more agile on land). This would be a logical additional segregation in terms of functional hearing within marine mammals.

Hearing has also been tested both in terms of absolute and masked hearing capabilities in manatees (Gerstein et al., 1999; Mann et al., 2005). The combined data suggest that manatees have hearing capabilities that are generally similar to phocid pinnipeds except perhaps at the lowest frequencies, with functional hearing between about 250 Hz and ~90 kHz. Behavioral tests suggest that best sensitivities are from 6-20 kHz (Gerstein et al., 1999) or 8-32 kHz (Bauer et al., 2010). Based on these data, the extrapolation of pinniped data to manatees, where information is lacking, would seem reasonable.

3.1.9.4. Functional Hearing Groups

Southall et al. (2007) recognized five functional hearing groups of marine mammals:

- Low-frequency cetaceans (7 Hz-22 kHz);
- Mid-frequency cetaceans (150 Hz-160 kHz);
- High-frequency cetaceans (200 Hz-180 kHz);
- Pinnipeds in water (75 Hz-75 kHz); and
- Pinnipeds in air (75 Hz-30 kHz).

As shown in **Table A-8**, all of the listed mysticete whales in the BA Area are in the low-frequency hearing group, and the sperm whale is in the mid-frequency group. As noted above, the hearing of the Florida manatee is considered similar to that of pinnipeds in water.

3.2. SEA TURTLES

3.2.1. Introduction

Five sea turtle species occur in the BA area (**Table A-10**): loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*). The leatherback is the only extant member of the family Dermochelyidae, whereas the other four turtles are members of the family Cheloniidae. Loggerhead, leatherback, and green turtles are more commonly found within the BA Area at certain periods (nesting season) and life stages. Kemp’s ridley and particularly hawksbill turtles are less common within the BA Area. Green, leatherback, and loggerhead turtles use coastal beaches within the BA Area as primary nesting sites, with the main nesting beaches in southeast Florida. However, loggerhead turtles also nest as far north as Virginia.

All sea turtles are protected under the ESA. Because sea turtles use terrestrial and marine environments at different life stages, the FWS and NMFS share jurisdiction over sea turtles under the ESA. The FWS has jurisdiction over nesting beaches, and NMFS has jurisdiction in the marine environment. The hawksbill, Kemp's ridley, and leatherback turtles are listed under the ESA as endangered. The green turtle is listed as threatened, except for the Florida breeding population, which is endangered (USDOC, NMFS, 2011c). The Northwest Atlantic population of the loggerhead turtle is currently listed as threatened (*Federal Register*, 2011c; USDOC, NMFS, 2011d).

The FWS and NMFS have designated critical habitat for the green, hawksbill, and leatherback turtles (**Table A-10**), but there is no critical habitat within or adjacent to the BA Area. On February 17, 2010, FWS and NMFS were jointly petitioned to designate critical habitat for Kemp's ridley sea turtles for nesting beaches along the Texas coast and marine habitats in the Gulf of Mexico and Atlantic Ocean (WildEarth Guardians, 2010). The NMFS is currently reviewing the petition.

Table A-10

Sea Turtles Occurring in the Biological Assessment Area

Common Name	Scientific Name	Status[1]	Occurrence in Area of Interest	Life Stage	Primary Nesting Sites	States with Nesting Reported in Biological Assessment Area	ESA Designated Critical Habitat
Loggerhead turtle	*Caretta caretta*	T[2]	DE–FL	All	Florida beaches: Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties	VA, NC, SC, GA, FL	None
Green turtle	*Chelonia mydas*	E, T[3]	DE–FL	All	Florida beaches: Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties	NC, SC, GA, FL	Culebra Island, Puerto Rico
Hawksbill turtle	*Eretmochelys imbricata*	E	DE–FL (uncommon north of FL)	All	Mexican beaches: Yucatán Peninsula; Caribbean Beaches: Puerto Rico (Culebra, Mona, and Vieques Islands), Barbados	--	Mona, Culebrita, and Culebra Islands, Puerto Rico; specific beaches on Culebra Island (Playa Resaca, Playa Brava, and Playa Larga), and the waters surrounding the islands of Mona and Monito
Kemp's ridley turtle	*Lepidochelys kempii*	E	DE–FL	Juveniles and Adults	Mexican beaches: Tamaulipas and Veracruz	NC, SC, FL	None
Leatherback turtle	*Dermochelys coriacea*	E	DE–FL	All	Florida beaches (southeast coast)	NC, SC, GA, FL	U.S. Virgin Islands: a strip of land 0.2-mi wide at Sandy Point Beach, St. Croix and the waters adjacent to the site

[1] Status: E = endangered (E); T = threatened.
[2] The Northwest Atlantic Distinct Population Segment of the loggerhead turtle is currently listed as threatened (*Federal Register*, 2011c).
[3] The green turtle is threatened, except for the Florida breeding population, which is endangered (USDOC, NMFS, 2011c).

Important marine habitats for sea turtles in and near the BA Area include nesting beaches, estuaries and embayments, nearshore hard substrate areas, and the Gulf Stream. Within the BA Area, sea turtle nesting occurs on sandy beaches from Virginia to Florida, as can be seen in the relative distribution and densities of sea turtle nests reported from individual counties within the BA Area for the 2010 nesting season (**Figure A-11**). Most sea turtle species move geographically, either seasonally or between nesting activities. Turtles may move seasonally into foraging habitats through migration corridors and to nesting beaches. The size of "resident" foraging habitats appears to vary with species and location. Studies suggest that resident foraging area size in the western North Atlantic decreases in a north-to-south gradient, possibly due to increasing available food resources and decreasing width of the continental shelf (Griffin, 2002).

Nesting beaches within the BA Area are subject to periodic impacts from tropical cyclones (including hurricanes and tropical storms). Studies suggest that tropical cyclones are a significant factor in observed sea turtle nesting declines (van Houtan and Bass, 2007). It is anticipated that the frequency of these storm events is likely to increase with changes in global climate (Webster et al., 2005; Pike and Stiner, 2007). Generally, storm-induced impacts to nesting beaches include beach flooding and the displacement of large volumes of sand (Pike and Stiner, 2007). Sea turtle eggs lose and gain water quickly depending on nest conditions, and nests exposed to seawater may be lost due to inhibited oxygen exchange or rapid water loss to saline seawater (Packard, 1999). Displacement of sand during storm events may expose and destroy established nests or may alter beach morphology to where it is not suitable for nesting habitat. Factors that may affect nesting success during storm seasons include the distance of the nest from shore and/or the nest depth, and nesting season.

Embayments such as Chesapeake Bay and Delaware Bay provide important foraging and developmental habitat for sea turtles (Musick, 1988; Coles, 1999; Spotila et al., 2000). Exposed hard substrate in shallow nearshore areas off eastern Florida provide important foraging and developmental habitats for cheloniid sea turtles, particularly juveniles and subadults (CSA International, Inc., 2009). The Gulf Stream is a key oceanographic feature that is utilized by sea turtles for various purposes, such as migration (Hoffman and Fritts, 1982). *Sargassum* mats that form in convergence zones associated with the Gulf Stream provide shelter and foraging habitat for hatchling and post-hatchling sea turtles (Carr and Meylan, 1980; South Atlantic Fishery Management Council [SAFMC], 2002).

Hearing capabilities of sea turtles are not well documented. Sea turtles appear to be low frequency specialists, with best hearing projected to occur within the frequency range of 50-1,000 Hz. See **Section 3.2.7** for further information on sea turtle hearing.

Existing Federal and State measures to reduce anthropogenic impacts on sea turtles are considered part of the environmental baseline and are discussed in **Section 4.2.2**.

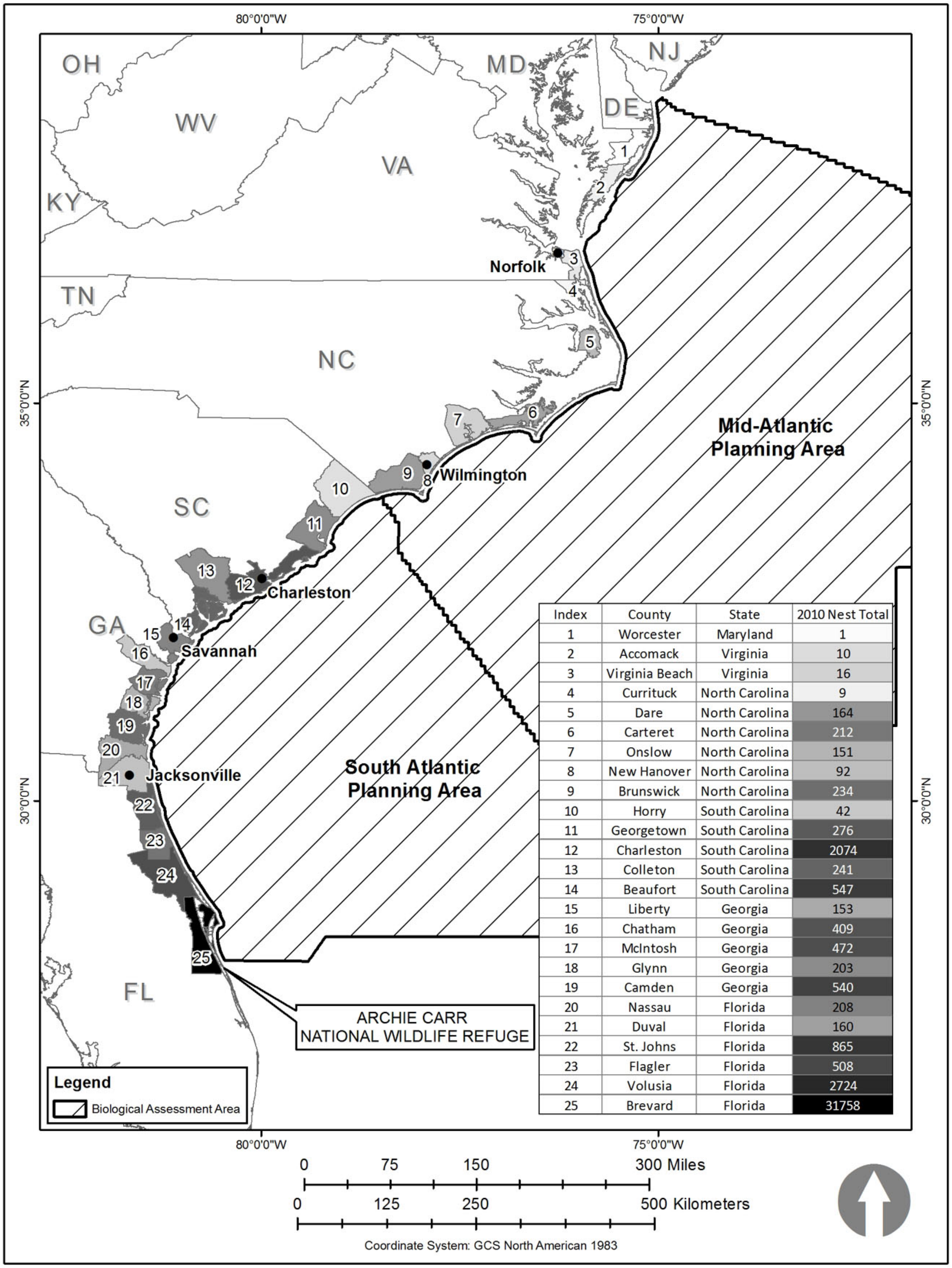
3.2.2. Loggerhead Sea Turtle (*Caretta caretta*)

3.2.2.1. Species Overview

The loggerhead turtle is the largest hard-shelled turtle. The typical adult carapace length is 85-100 cm, and most mature individuals weigh approximately 135 kg (Ernst et al., 1994). The carapace, when viewed from above, is elongated and heart- or shield-shaped (Márquez-M, 1990). The color of adults is reddish brown above, and many of the overlying scutes are tinged with yellow. The underside is orange to creamy yellow (Ernst et al., 1994).

The loggerhead is a circumglobal species that is found from tropical to temperate regions. They range through the Pacific, Indian, and Atlantic Oceans from Alaska, eastern Russia, Newfoundland, and Norway south to Chile, Australia, and South Africa (Ernst et al., 1994). In the Atlantic Ocean, the loggerhead turtle is reported from Newfoundland, the Caribbean Sea, the Gulf of Mexico, and along the east coast of the U.S. Loggerhead turtles, like other sea turtles, are highly migratory, making various seasonal and annual migrations (Godley et al., 2003). Moncada et al. (2010) reported that it is common for loggerhead turtles to make extended transoceanic journeys and then later return to specific nesting beaches.

Loggerhead turtles use three different types of habitats throughout their life: terrestrial (beaches), neritic (nearshore waters), and oceanic (open ocean) (USDOC, NMFS and USDOI, FWS, 2008). They are carnivores, feeding primarily on mollusks and crustaceans (USDOC, NMFS and USDOI, FWS, 2008).



Index	County	State	2010 Nest Total
1	Worcester	Maryland	1
2	Accomack	Virginia	10
3	Virginia Beach	Virginia	16
4	Currituck	North Carolina	9
5	Dare	North Carolina	164
6	Carteret	North Carolina	212
7	Onslow	North Carolina	151
8	New Hanover	North Carolina	92
9	Brunswick	North Carolina	234
10	Horry	South Carolina	42
11	Georgetown	South Carolina	276
12	Charleston	South Carolina	2074
13	Colleton	South Carolina	241
14	Beaufort	South Carolina	547
15	Liberty	Georgia	153
16	Chatham	Georgia	409
17	McIntosh	Georgia	472
18	Glynn	Georgia	203
19	Camden	Georgia	540
20	Nassau	Florida	208
21	Duval	Florida	160
22	St. Johns	Florida	865
23	Flagler	Florida	508
24	Volusia	Florida	2724
25	Brevard	Florida	31758

Figure A-11. Densities of Sea Turtle Nests Reported for Individual Counties inshore of the Biological Assessment Area for the 2010 Nesting Season. Sources: http://www.seaturtle.org/nestdb/ (NC, SC, and GA); http://myfwc.com/research/wildlife/sea-turtles/nesting/ (FL).

The southeast U.S. coast is among the most important areas in the world for loggerhead nesting. The east Florida coast is the most important area (**Figure A-12**). The USDOC, NMFS and USDOI, FWS (2008) report that about 80 percent of loggerhead nesting in this region occurs in six Florida counties (Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward). Loggerhead turtle nesting in the western North Atlantic is from April to September, with peak nesting occurring in June and July (Weishampel et al., 2006). Age at sexual maturity is late in life at around 35 years of age, and breeding adult females nest, on average, every 2.5-3.7 years. Clutch size is between 100 and 126 eggs, and incubation is between 42 and 75 days. The mean number of nests is 3-5.5 per breeding season, with internesting intervals ranging from 12-15 days (USDOC, NMFS and USDOI, FWS, 2008).

Immediately after loggerhead turtle hatchlings emerge from the nest, they actively swim offshore into oceanic areas of local convergence zones and major gyre systems, often characterized by accumulations of floating *Sargassum*. The duration of this oceanic post-hatchling-juvenile stage is variable, but generally ranges between 7 and 12 years (Bolten and Witherington, 2003). Afterward, oceanic juveniles actively migrate to nearshore (neritic) developmental habitats.

Overall, the population structure of the loggerhead turtle is complex and challenging to evaluate (Bolten and Witherington, 2003). According to the Loggerhead Biological Review Team, there are nine significant populations of loggerhead turtles, termed distinct population segments (DPSs) (Conant et al., 2009). The Northwest Atlantic Ocean DPS occurs in an area bounded by 60º N latitude to the north and the equator to the south, with 40º W longitude as the eastern boundary. The NMFS has also identified five recovery units (nesting subpopulations) within the Northwest Atlantic DPS (USDOC, NMFS and USDOI, FWS, 2008) of which four occur in the southeastern U.S. and Gulf of Mexico (**Figure A-13**). Two of these recovery units are within the BA Area: the Northern Recovery Unit (NRU), extending from the Florida-Georgia border through southern Virginia (the northern extent of the nesting range), and the Peninsular Florida Recovery Unit (PFRU), extending south from the Florida-Georgia border through Pinellas County on the west coast of Florida, excluding the islands west of Key West, Florida.

The loggerhead turtle nesting season extends from May 1 to October 31. The total number of loggerhead nests per year in the U.S. over the last decade has been estimated at between 47,000 and 90,000 (USDOC, NMFS and USDOI, FWS, 2008). The current recovery plan reported that the number of nests in the NRU averaged 5,215 nests annually during 1989 through 2008, and the nesting trend declined 1.3 percent. In the PFRU, the number of nests averaged 64,513 nests annually during 1989 through 2007, and the nesting trend declined 1.6 percent.

Similar to most sea turtle populations, the loggerhead turtle is severely depleted; however, the population is probably the most stable population of any sea turtle. To date, projections indicated that the Northwest Atlantic loggerhead turtle population was slightly declining but expected to recover in the next 50-150 years (USDOC, NMFS and USDOI, FWS, 2008). The South Carolina Department of Natural Resources (SCDNR, 2005a) recently reported that juvenile loggerheads were more abundant now in South Carolina coastal waters than they were in the 1970's. Most of the nests in South Carolina were reported near Georgetown (44.5 percent), Charleston (26.4 percent), and Beaufort (21.9 percent). Even so, the population is still at risk of extinction given the current continuing threats (Conant et al., 2009).

In March 2010, NMFS and FWS proposed to list the Northwest Atlantic Ocean DPS of loggerhead turtles as endangered (*Federal Register*, 2010d). The final rule, listing this DPS as threatened, was filed on September 16, 2011 (*Federal Register*, 2011c).

Information about daily movement and dive behaviors of loggerheads in the open ocean is limited, but new technology has allowed researchers to recently study this type of behavior in the turtles' natural environment (Sobin, 2008). Houghton et al. (2000) recorded observations of loggerhead turtles around the Greek Island of Kefalonia and discovered that these individuals made frequent shorter-duration dives than previously reported. On average, four loggerhead turtles made 96 dives over 29 days, with dive durations ranging from 1-5 min. Off Hawaii, four turtles (two loggerhead turtles and two olive ridley turtles) were monitored to evaluate their dive depth distributions to understand how mitigation measures could be implemented for longline fisheries. Based on the research, Polovina et al. (2003) found that there were diurnal and species differences in the dive profiles. Overall, the researchers found that all turtles spent more time at the surface and dove deeper during the day than at night. Loggerhead turtles spent 40 percent of their time at or near the surface and at less than 100-m (328-ft) depths; most (70 percent) of the dives were no deeper than 5 m (16.4 ft). The deepest dive recorded for one of the loggerhead turtles was 178 m (584 ft). Loggerhead diving behavior off Japan was shown to be somewhat size-dependent (Hatase et al., 2007). In southwest Florida, Sobin (2008) reported that loggerhead turtles spent more time near the surface in the morning (08:00-12:00 h) than in the evening, which was different than previous studies.

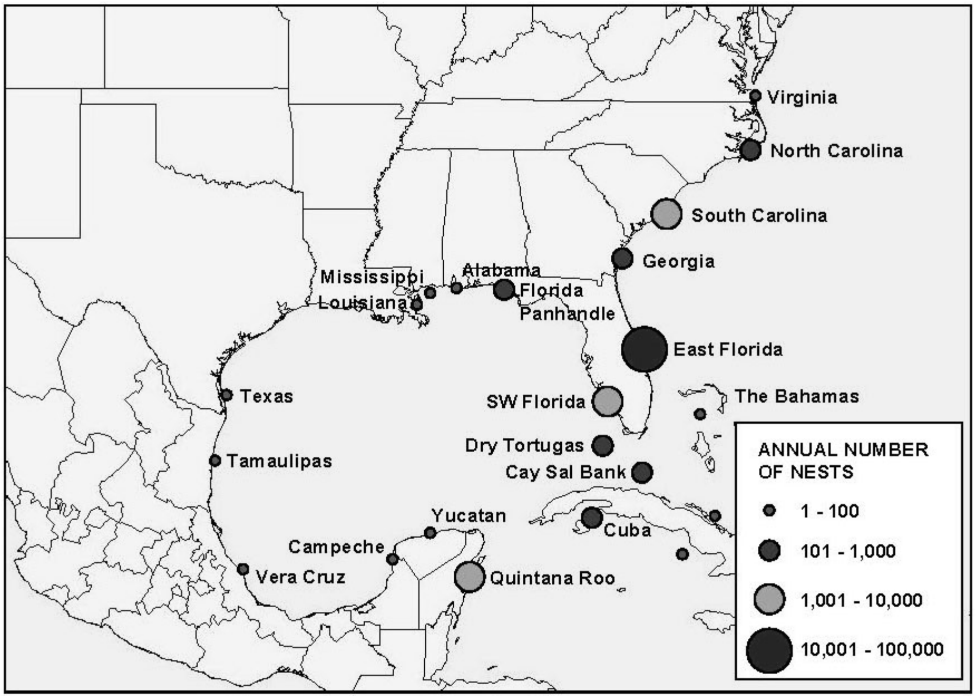


Figure A-12. Estimated Annual Number of Loggerhead Nests in the Southeastern U.S., The Bahamas (Including Cay Sal Bank), Cuba, and Mexico from 2001-2008. Source: USDOC, NMFS and USDOI, FWS (2008).

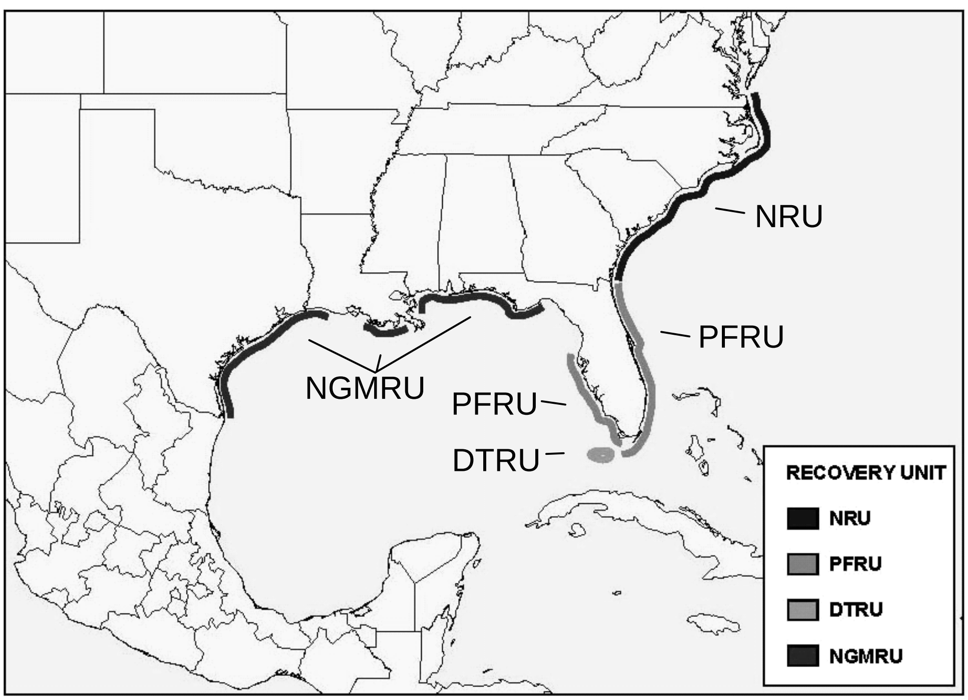


Figure A-13. Location of the Four Recovery Units for the Loggerhead Turtle in the U.S. NRU = Northern Recovery Unit, PFRU = Peninsular Florida Recovery Unit, DTRU = Dry Tortugas Recovery Unit, NGMRU = Northern Gulf of Mexico Recovery Unit. Source: USDOC, NMFS and USDOI, FWS (2008).

3.2.2.2. Presence and Abundance within the Biological Assessment Area

Loggerhead turtles are likely to be the most common sea turtle species in the BA Area. Based on nesting information, loggerhead turtle nests are primarily located in five of the seven states in the BA Area: Florida (91 percent), South Carolina (6.5 percent), Georgia (1.5 percent), North Carolina (1 percent), and Virginia (<1 percent). The NRU is the second largest subpopulation in the U.S., and South Carolina represents about 65 percent of those nests (SCDNR, 2005a). In Florida, Brevard County is located within the BA Area, while Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties are south of the BA Area. Within this region south of the BA Area, there is a 20-mi (32.2-km) section of coastline from Melbourne Beach to Wabasso Beach that comprises the Archie Carr National Wildlife Refuge (NWR), which has been identified as the most important nesting area for loggerhead turtles in the western hemisphere (USDOC, NMFS and USDOI, FWS, 2008); this stretch of coastline borders the BA Area (see **Figure A-11**). The Archie Carr NWR is critical to the recovery and survival of loggerhead turtles; it has been estimated that 25 percent of all loggerhead nesting in the U.S. occurs there. Nesting densities within the Archie Carr NWR have been estimated at 625 nests per km (1,000 nests per mile).

Neritic juvenile loggerhead turtles are likely to occupy shallow water developmental habitats in nearshore areas of the BA Area. Some neritic juveniles make seasonal foraging migrations into nearshore waters and embayments within temperate latitudes as far north as New York. To avoid cold temperatures, most juvenile loggerheads move into waters south of Cape Hatteras, North Carolina, by January (Musick and Limpus, 1997).

3.2.2.3. Critical Habitat

There is no designated critical habitat for the loggerhead turtle within the BA Area.

3.2.3. Green Sea Turtle (*Chelonia mydas*)

3.2.3.1. Species Overview

The green turtle is the largest cheloniid sea turtle; adults can reach 0.91 m (3 ft) in carapace length and range between 136 and 159 kg (300 and 350 lb) in mass. The carapace shape is depressed and oval in shape when viewed from above (Márquez-M, 1990). The head is small and blunt. The carapace color ranges from pale to very dark and from plain color to radiated stripes or blotches of yellow, brown, and greenish tones. The underside ranges from white to dirty white or yellowish white (Márquez-M, 1990).

The green turtle is a circumglobal species that is found in the Mediterranean Sea and Pacific, Indian, and Atlantic Oceans (USDOC, NMFS and USDOI, FWS, 1991, 2007a). The green turtle can be found in tropical and subtropical waters between 30° N and 30° S latitude, and, to a lesser extent, in temperate waters (USDOC, NMFS and USDOI, FWS, 2007a). Similar to other sea turtles, satellite tagging data indicate that green turtles display highly migratory behavior, making vast seasonal and annual transoceanic migrations (Godley et al., 2003, 2008, 2010).

Breeding populations in Florida and on the Pacific coast of Mexico are listed as endangered under the ESA, whereas the remaining populations are listed as threatened. The Florida breeding population is listed by the State of Florida as endangered (USDOC, NMFS, 2011c). The green turtle is considered severely depleted in comparison to its estimated historical levels (USDOC, NMFS and USDOI, FWS, 2007a). Currently, there is no reliable green turtle population estimate, but inferences have been attempted using age-based survivability models and nesting data (Bjorndal et al., 2003). Nesting data indicate that between 200 and 1,100 females nest annually on continental U.S. beaches (within the BA Area). The recent 5-year status review (USDOC, NMFS and USDOI, FWS, 2007a) reported that the total mean annual green turtle nesting abundance was around 5,600 nests (Florida east coast) during 2000 through 2006, and the number of nests appears to be increasing. Overall, the number of green turtle nests in Florida has increased over the last 18 years (USDOC, NMFS and USDOI, FWS, 2007a). In addition, the numbers of immature green turtles incidentally captured at the St. Lucie power plant (St. Lucie County, Florida; south of the BA Area) has also increased during the past 26 years, which could indicate the population is improving (Florida Power and Light Company and Quantum Resources, Inc., 2005). It is difficult to evaluate how common or rare green turtle occurrence is in comparison to the other sea turtles (excluding hawksbill and Kemp's ridley) found within the BA Area, but in terms of the number of nests surveyed in Florida in 2010, green turtles ranked second (Florida Fish and Wildlife Conservation Commission, 2011).

The green turtle is protected and managed by NMFS and the FWS. Under the leadership of these Federal agencies, various conservation and recovery strategies have been implemented since green turtles were listed under the protection of the ESA. In 1998, the agencies jointly designated critical habitat for the green turtle in the waters of Culebra Island, Puerto Rico, and its outlying keys (*Federal Register*, 1998a). A variety of restrictions on commercial fishery activities (e.g., requiring the use of circle hooks in pelagic longline fisheries and turtle excluder devices [TEDs] in trawls) were implemented to prevent serious injury and mortality to sea turtles, as well as a gear-based approach to reduce interactions called the Strategy for Sea Turtle Conservation and Recovery for Atlantic and Gulf of Mexico Fisheries. Additional conservation measures include restrictions on beach lighting and hopper dredging during the sea turtle nesting season.

The green turtle diet consists of seagrasses and macroalgae. Hazel et al. (2009) documented various daily diving behaviors related to foraging activity of green turtles in nearshore foraging habitats in Australia. They found that the majority of turtles spent most time (89-100 percent) at depths near the surface (<5 m [16.4 ft]). They also found that dives were shorter and shallower during the day than at night, suggesting that green turtles rest at night and forage during the day, consistent with the requirement to surface more often during increased activity (daytime foraging). In addition, Hazel et al. (2009) found that green turtle dives became longer as water temperatures decreased. Off the Hawaiian Islands, Rice and Balazs (2008) documented the diving behavior of two adult green turtles in the open-ocean environment. Their results demonstrated that green turtles also displayed a shallow daytime and deeper nighttime dive pattern. In general, two green turtles stayed near the surface during the day and dove to between 35 and 55 m (115 and 180 ft) at night, with dive durations of 33-44 min. A new maximum dive depth was recorded for the green turtle, with two dives by one female greater than 135 m (443 ft) and one dive by one male to 100 m (328 ft) (Rice and Balazs, 2008).

Nesting generally occurs from June to September in the southeastern U.S. Females nest at 2- to 4-year intervals. Similar to other sea turtle species, age at sexual maturity is not reached until late in life at around 20-50 years of age. Clutch size varies from 75-200 eggs, and incubation is between 20 and 50 days. Female green turtles usually deposit two or three clutches per breeding season, with internesting intervals ranging from 12-14 days (USDOC, NMFS and USDOI, FWS, 2007a).

After leaving the nest, green turtle hatchlings swim offshore to areas of convergence zones characterized with driftlines and patches of *Sargassum.* Experiments with post-hatchling green turtles in the laboratory suggest that they prefer open ocean habitats more than loggerhead or hawksbill turtles and so may avoid floatlines of *Sargassum* (Musick and Limpus, 1997). Data also suggest that recruitment of green turtles into neritic developmental habitats occurs at smaller body sizes (30-40 cm) than for loggerhead turtles (Bjorndal and Bolten, 1988).

3.2.3.2. Presence and Abundance within the Biological Assessment Area

In the western North Atlantic, green turtles can be found on various coastal beaches during the nesting season. Important nesting areas for green turtles include Florida beaches within Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties. Most green turtles nest in Brevard County (USDOC, NMFS and USDOI, FWS, 2007a). Except for the beaches of Brevard County, the primary green turtle nesting sites are south of the BA Area.

After nesting, green turtles are found feeding or swimming along nearshore or offshore waters from Florida to Massachusetts (USDOC, NMFS and USDOI, FWS, 2007a). Based on satellite tagging research, green turtles display daily and seasonal movement patterns that are associated with foraging strategies (Hart and Fujisaki, 2010). Green turtles are vulnerable to cold temperatures, so in many locations they are found only seasonally within northern portions of the BA Area (Foley et al., 2007). Green turtles are reported to use the coastal waters of North Carolina and Virginia as summer foraging habitat (Mansfield et al., 2009). Further south, green turtles have been reported to use the Indian River Lagoon (Florida) and areas south of the BA Area (Florida Bay and the Florida Keys) as feeding areas. The USDOC, NMFS and USDOI, FWS (2007a) status review highlights the Florida east coast (from Indian River Lagoon and the waters off Brevard County [within the BA Area] south to Broward County [south of the BA Area]) as prime foraging area for green turtles.

Neritic developmental habitats for juvenile green turtles in the western North Atlantic range from Long Island Sound to South Florida and the tropics. These habitats include shallow nearshore hard substrate, embayments, and other inshore habitats (e.g., Indian River Lagoon [Florida]). Locations with optimal habitats (e.g., sources of marine algae) are likely locations where small juvenile green turtles may be found. McClellan and Read (2009) documented the seasonal habitat-use patterns of juvenile green turtles in the estuaries (i.e., salt marshes, tidal creeks, and marsh islands) of North Carolina (Pamlico Sound, Cape Hatteras Region). Juvenile green turtles occupying developmental habitats north of Florida must migrate south in autumn (Musick and Limpus, 1997). Therefore, juvenile green turtles may occur within nearshore and inshore habitats throughout the BA Area.

3.2.3.3. Critical Habitat

There is no designated critical habitat for the green turtle within the BA Area.

3.2.4. Hawksbill Sea Turtle (*Eretmochelys imbricata*)

3.2.4.1. Species Description and Status

The hawksbill is a small to medium-sized sea turtle. Adults can reach to 1.1 m (3.5 ft) in carapace length and 82 kg (180 lb) in mass (USDOC, NMFS and USDOI, FWS, 2007b). The carapace is shield shaped, and dorsal scutes are overlapping on younger individuals (Ernst et al., 1994). The hawksbill is the most colorful among the sea turtle species. The carapace in younger individuals shows the characteristic “tortoiseshell” pattern, which gradually, with age, becomes a dark greenish brown. The plastron is yellow. The head is medium-sized and elongated with a pointed beak (Márquez-M, 1990).

The hawksbill turtle is a circumglobal species that is found in the Pacific, Indian, and Atlantic Oceans (USDOC, NMFS and USDOI, FWS, 2007b). The hawksbill turtle can be found in tropical and subtropical waters between latitudes 30° N and 30° S (USDOC, NMFS and USDOI, FWS, 2007b). Hawksbill turtles display highly migratory behavior, with satellite tagging data demonstrating that these turtles display both short and long migrations from nesting to foraging grounds (USDOC, NMFS and USDOI, FWS, 2007b; Blumenthal et al., 2009).

The hawksbill turtle is currently listed as endangered under the ESA. The conservation and recovery of the hawksbill turtle is administered through various regulatory mechanisms, such as designating critical habitat and implementing conservation regulations, including commercial fishery measures to prevent serious injury and mortality to sea turtles. Campbell et al. (2009) indicate that the co-management between local communities and government agencies is a strategy to improve fisheries management that has the potential to reduce sea turtle fishery interactions. The agencies also support several international agreements for the conservation of sea turtles, such as the South-East Asian Marine Turtle Memorandum of Understanding in the Indian Ocean. The recovery of the hawksbill turtle population is threatened by many ongoing anthropogenic threats, including commercial fishery interactions, habitat loss (i.e., reefs), global climatic changes (sea level rise), and fibropapillomatosis (USDOC, NMFS and USDOI, FWS, 2007b). In addition, the continued overutilization of hawksbill turtles for commercial, recreational, scientific, or educational purposes is another major threat to the recovery of the species (USDOC, NMFS and USDOI, FWS, 2007b).

Adult hawksbill turtles specialize on a diet of sponges and feed very selectively on specific species of demosponges (Bjorndal, 1997). They may also consume a variety of other food items, such as algae and other benthic invertebrates (Márquez-M, 1990). In the Caribbean, hawksbill turtles are often sighted feeding along coral reefs and hard bottom communities (Blumenthal et al., 2009).

There is some information about the diving behavior of hawksbill turtles. In Milman Island, Australia, Bell and Parmenter (2008) recorded the diving behavior of nine female hawksbill turtles that had previously laid eggs and two females that had not successfully laid any eggs. Results from the study showed that the nine hawksbill turtles primarily spent their time near the surface but did make occasional deeper dives. The maximum depth recorded was 21.5 m (70.5 ft), and the researchers did not find any significant difference between day and night dive behaviors. On average, the dive time and surface interval for the nine turtles were 31.2 and 1.6 min, respectively. On the reefs of Mona Island, Puerto Rico, van Dam and Diez (1997) reported the diving patterns of five foraging juvenile hawksbill turtles. Results showed that individual mean dive depths ranged from 8-10 m (26-33 ft), dive durations ranged from 19-26 min, and surface intervals ranged from 37-64 s. Night dives ranged from 7-10 m (23-33 ft), dive durations ranged from 35-47 min, and surface intervals ranged from 36-60 s (van Dam and Diez, 1997).

Hawksbill turtles primarily nest on Mexican (Yucatán Peninsula) and Caribbean (Puerto Rico [Culebra, Mona, and Vieques Islands] to Barbados) beaches. Some nesting has been reported in South Florida and the Florida Keys, but this is considered rare (USDOC, NMFS and USDOI, FWS, 1993). Depending on the location, the nesting season occurs during various summer and fall months (USDOC, NMFS and USDOI, FWS, 1993). For example, hawksbill nesting occurs from July-October on Buck Island (U.S. Virgin Islands) and from August-October on Mona Island (Puerto Rico), with females nesting at 2- or 3-year intervals. In Barbados, West Indies, nesting is reported to occur year-round, with peak months from June-August (Beggs et al., 2007). These researchers also discovered that nesting intervals ranged from 2-6 years with a mean of 2.5 years. Overall, the average nesting season for the hawksbill turtle (6 months) is longer than for any other sea turtle (USDOC, NMFS and USDOI, FWS, 1993). Female hawksbill turtles usually deposit three to five clutches per breeding season at intervals of about 14 days (Beggs et al., 2007; USDOC, NMFS and USDOI, FWS, 2007b). Age at sexual maturity is between 20 and 40 years; average clutch size is around 135 eggs, and incubation is around 60 days.

Hatchling hawksbill turtles emerge from the nest and actively swim offshore at night to areas of water mass convergence. Hawksbill post-hatchlings in the laboratory appear to be attracted to patches of floating *Sargassum*, which they use as protective cover (USDOC, NMFS and USDOI, FWS, 1993; Musick and Limpus, 1997). Data suggest that juvenile (or post-hatchling) hawksbills move into neritic developmental habitats at a smaller size than loggerhead turtles; neritic developmental habitats include shallow coral reefs and mangrove estuaries (Carr, 1952; Witzell, 1983) and Caribbean seagrass habitats (Bjorndal and Bolten, 1988, 2010).

3.2.4.2. Presence and Abundance within the Biological Assessment Area

In the western North Atlantic, hawksbill turtles can be found from Florida to Massachusetts, but they are rarely reported north of Florida. The hawksbill turtle has a restricted distribution and range given that its habitat (foraging) preference is coral reefs and mangrove estuaries, which are found only in near coastal areas to the south of the BA Area. Although it is a rare occurrence, USDOC, NMFS and USDOI, FWS (1993) report that hawksbill nesting has occurred not only in South Florida counties (Broward, Miami-Dade, Martin, and Palm Beach) but also in Volusia County, which is within the BA Area. Neritic developmental habitats for juvenile hawksbills also include shallow coral reefs and mangrove estuaries (Witzell, 1983).

3.2.4.3. Critical Habitat

There is no designated critical habitat for the hawksbill turtle within the BA Area. Critical habitat for the hawksbill turtle was originally designated in 1982 and subsequently in 1998 (*Federal Register*, 1998a) off Mona, Culebrita, and Culebra Islands in Puerto Rico, and the waters surrounding the islands of Mona and Monito (3-5 km [1.9-3.1 mi] from shore). Critical habitat also includes specific beaches on Culebra Island (Playa Resaca, Playa Brava, and Playa Larga).

3.2.5. Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)

3.2.5.1. Species Overview

The Kemp's ridley is the smallest sea turtle; adults reach only 76 cm (30 in.) in carapace length and range from 36-45 kg (80-100 lb) in mass. The carapace of adults is nearly round in shape when viewed from above. The color of adults is plain olive-gray dorsally and white or yellowish white underneath (Márquez-M, 1990).

The Kemp's ridley is generally found in the Gulf of Mexico and occasionally sighted along the east coast from Florida to New England (USDOC, NMFS et al., 2010). Similar to other sea turtles, Kemp's ridley turtles display some seasonal and coastal migratory behavior. Satellite tagging data indicate that Kemp's ridley turtles transit between nearshore and offshore waters (within 28 km [50 mi] from shore) from spring/summer to fall/winter, which coincides with seasonal water temperature changes (USDOC, NMFS et al., 2010).

The Kemp's ridley is currently listed as endangered under the ESA. The population is severely depleted, and it is considered the most endangered sea turtle species (USDOI, FWS, 1999). Kemp's ridley turtles were once abundant, especially in the Gulf of Mexico, but today the species is struggling. At one single nesting event (arribada) in Rancho Nuevo, Mexico, during 1947, approximately 42,000 nesting females were reported (USDOC, NMFS et al., 2010). However, by the mid-1980's, the number of nests had declined to about only 700 nests per year. Today, the population is stressed and there are no reliable Kemp's ridley turtle population estimates. Given that most of the Kemp's ridley turtle population nests in one location, better population estimates have been inferred from nesting data (USDOI, FWS, 1999). Using various assumptions, the current population estimate of Kemp's ridley turtles is approximately 738 females. Márquez-M (2001) indicated that the annual number of nests in Tamaulipas, Mexico, has increased between 8 and 12 percent since 1988. USDOC, NMFS et al. (2010) reported that the number of nests per season in Rancho Nuevo, Mexico, recently exceeded 20,000 and stated that the nesting population is growing exponentially.

The Kemp's ridley is a carnivore throughout its life cycle (Márquez-M, 1990). Adult and subadult Kemp's ridley turtles are benthic feeders that primarily feed on crabs. Other preferred food items include shrimps, mollusks, sea urchins, and fishes (opportunistically) (USDOC, NMFS et al., 2010).

Kemp's ridleys primarily nest on Gulf of Mexico beaches in Mexico (Tamaulipas and Veracruz) during April through July. The mean number of clutches is 2.5 per breeding season (14-28 days), average clutch size is around 100 eggs, and incubation is between 45 and 58 days. Females nest at 2-year intervals (USDOC, NMFS et al., 2010). Age at sexual maturity has been reported to be much younger than for other turtles, at around 10-20 years with a mean of 12 years.

Available information about Kemp's ridleys in the open ocean is limited, but there is some information about their diving behavior. In the Gulf of Mexico, Schmid et al. (2002) reported a surface interval between 1 and 88 s, and a mean submergence duration of 8.4 min. Overall, these researchers did not find any differences between day and night surface activities, but did find a diel difference in some years (1994 versus 1995). The data also showed that the mean submergence interval during the night was longer than during the day (Schmid et al., 2002).

3.2.5.2. Presence and Abundance within the Biological Assessment Area

Overall, the Kemp's ridley may be the least abundant sea turtle in the BA Area. There is some evidence of Kemp's ridleys nesting on beaches within the BA Area, but this is considered rare (USDOC, NMFS et al., 2010). Johnson et al. (1999) reported that Kemp's ridleys nest on the beaches of North Carolina, South Carolina, and Florida (Ponce Inlet and New Smyrna Beach, Volusia County); all of these locales are adjacent to the BA Area. Johnson et al. (1999) also reported Kemp's ridleys nesting in Palm Beach County, Florida, which is south of the BA Area.

Foraging areas along the Atlantic coast include various embayments and estuarine systems from Florida to New York. Coles (1999) reported that Kemp's ridleys were frequently sighted in Chesapeake Bay during the summer over a continuous 18-year sea turtle stranding survey and indicated that Kemp's ridleys ranked second in the number of strandings per year in the Mid-Atlantic Bight. Coles (1999) also indicated that the Mid-Atlantic Bight is an important foraging area for juvenile Kemp's ridleys during spring through fall.

3.2.5.3. Critical Habitat

There is no critical habitat designated for the Kemp's ridley within the BA Area.

3.2.6. Leatherback Sea Turtle (*Dermochelys coriacea*)

3.2.6.1. Species Overview

The leatherback is the largest sea turtle. Adults reach up to 1.8 m (6 ft) in carapace length and 907 kg (2,000 lb) in mass. They are easily distinguished from all other sea turtle species by their large spindle-shaped, leathery, and unscaled carapaces that possess a series of parallel dorsal ridges, or keels

(Márquez-M, 1990). Their color is brown to black, with small, scattered white, yellowish, or pink blotches. Leatherback fore-flippers are large, paddle-shaped, and relatively longer than in other sea turtle species.

The leatherback is a cosmopolitan species that is found in the Mediterranean Sea and Indian, Pacific, and Atlantic Oceans; it is reported as having the widest distribution of any sea turtle (USDOC, NMFS and USDOI, FWS, 2007c). Leatherbacks have a wide-ranging distribution and apparently are able to adapt to and tolerate cold water temperatures; most leatherbacks sighted in the Chesapeake Bay were in waters between 25 °C and 29 °C (Coles, 1999). Coles (1999) indicated that sea turtle distribution may not be random but associated with specific water temperature ranges. In the Atlantic Ocean, the leatherback is reported throughout the North Sea, Canadian waters, and along the east coast of the U.S. and into the Gulf of Mexico and Caribbean Sea. Adult leatherbacks have been reported to migrate from equatorial to temperate waters to forage, which is unique for sea turtles (USDOC, NMFS and USDOI, FWS, 2007c).

Along the U.S. east coast, the principal nesting beaches for leatherbacks are in Florida. According to SCDNR (2005b), leatherback turtles have also been documented to nest in Georgia, South Carolina (four leatherback nests since 1996), North Carolina, and possibly in Maryland.

The leatherback is currently listed as endangered under the ESA. Similar to other sea turtles, its population is also depleted, although it is more stable than other species (USDOC, NMFS and USDOI, FWS, 2007c). Spotila et al. (1996) estimated there were about 115,000 individuals in 1980. The most recent population estimate for leatherback turtles in the Atlantic is smaller – between 34,000 and 94,000 – but apparently stable (USDOC, NMFS and USDOI, FWS, 2007c). Recent survey data clearly show that the nesting numbers have dramatically increased, from 98 nests in 1988 to around 850 nests in the early 2000's (USDOC, NMFS and USDOI, FWS, 2007c). Using the number of nests as a population index, the estimated annual growth rate for leatherback turtles is around 17 percent (USDOC, NMFS and USDOI, FWS, 2007c).

The conservation and recovery of the leatherback is governed through various regulatory mechanisms, such as attempting to meet specific recovery plan objectives, habitat protection efforts, and protecting nesting females. Other conservation measures include imposing restrictions on commercial fishery activities to prevent serious injury and mortality to sea turtles (e.g., circle hook requirements in the pelagic longline fishery and the use of TEDS in trawls) and supporting several international agreements, such as the Inter-American Convention for the Protection and Conservation of Sea Turtles. Moreover, NMFS has developed and is attempting to implement a Strategy for Sea Turtle Conservation and Recovery in Relation to Atlantic and Gulf of Mexico Fisheries, which focuses on specific commercial fishing gear-related criteria. To assist decision makers, agencies also fund many research projects, e.g., the South Carolina nearshore aerial and nesting surveys, and short-term telemetry studies (SCDNR, 2005b).

Leatherbacks have various anthropogenic threats to their recovery, which include but are not limited to commercial fisheries, habitat loss (nesting), climate change (e.g., sea level rise, shifts in prey availability), pollution, overutilization for commercial, recreational, scientific, or education purposes (e.g., egg harvesting), and disease (USDOC, NMFS and USDOI, FWS, 2007c).

Leatherbacks are highly migratory and have the most wide-ranging distribution of any sea turtle (Hays et al., 2006; USDOC, NMFS and USDOI, FWS, 2007c; Shillinger et al., 2008). Because leatherback turtles appear to adapt quickly to local environmental conditions, they do not display any restricted distributional and movement behaviors (Hays et al., 2006; USDOC, NMFS and USDOI, FWS, 2007c). In fact, Eckert (2006) reported that leatherbacks tagged in Trinidad were later reported off Newfoundland (Flemish Cap), Canada, and subsequently in Mauritanian waters. Genetic techniques have been used to distinguish five groups or populations in the western North Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean (including northern Brazil), and Southern Brazil (USDOC, NMFS and USDOI, FWS, 2007c). Genetic studies support the natal homing hypothesis, which has been reported for other sea turtles (Godley et al., 2010). Leatherbacks tend to use specific beach sites within their respective regions for nesting.

Leatherbacks primarily feed on pelagic gelatinous invertebrates such as scyphomedusae (jellyfish) and pelagic tunicates (USDOC, NMFS and USDOI, FWS, 1992; Bjorndal, 1997), and their seasonal movements appear to be correlated with jellyfish seasonal abundance (SCDNR, 2005b). Knowledge about leatherbacks in their open ocean environment is limited, but there is some published information about daily movement and dive behaviors. Off South Africa, Sale et al. (2006) investigated leatherback diving behavior during oceanic movements. Results from that study demonstrated that leatherbacks primarily dove to depths of less than 200 m (656 ft), and maximum dive durations were between 30 and 40 min. Findings also showed that leatherback turtles displayed differences in dive patterns depending on the time of day. At night and at specific periods, leatherbacks dove longer. Interestingly, the researchers reported some of the deepest and longest dives during the day for a few individuals. Using tagging data from nine turtles (181-431 days), Hays et al. (2006) also recorded seasonal movements from the south (Caribbean) to the north (northeastern coast of the U.S.) during the summer and from the north to the south during the fall. With these seasonal movements, the researchers found that as the individuals moved from southern to northern latitudes, the dives initially became longer but then became progressively shallower and shorter. In addition, Hays et al. (2006) documented that leatherbacks also displayed a diel dive pattern with more and shallower diving at night than during the day for the individuals located between 18° and 30° N latitude. Mean dive duration ranged from 3-30 min, and mean dive depth ranged from surface waters to almost 250 m (820 ft). The overall swimming speed ranged from 2.5-82.5 km (1.5-51.3 mi) per day; most leatherbacks swam between 32.5 and 42.5 km (20.2 and 26.4 mi) per day. Hays et al. (2006) concluded that leatherbacks do not display highly migratory behavior (i.e., swim from southern to northern waters) just to forage at specific "hotspots," but instead continuously feed as they travel. However, the researchers noted that leatherbacks did remain in specific areas for short durations to feed, and their daily diving patterns were correlated with prey abundance.

Nesting areas include beaches of the eastern Pacific Ocean, western Atlantic Ocean, eastern Atlantic Ocean, and Indo-Pacific region. In the western Atlantic, nesting beaches range from northern South America to the eastern coast of the U.S. as far north as Georgia (Márquez-M, 1990; Ernst et al., 1994). Unlike other sea turtles, leatherbacks can begin nesting much earlier in the year. Leatherbacks have been reported to nest as early as February or March with peak nesting in July; females nest at 2- or 3-year intervals. Age at sexual maturity has been reported to be much younger than for other sea turtles, at around 6-10 years. The average clutch size is around 100 eggs, and incubation is between 60 and 65 days. Females deposit between five and seven nests per breeding season, with internesting intervals ranging from 8-12 days (USDOC, NMFS and USDOI, FWS, 2007c).

Like other sea turtle species, hatchling leatherbacks leave the nest and swim actively offshore. Post-hatchling and oceanic juvenile leatherbacks are more active than other sea turtle species (Wyneken and Salmon, 1992). These oceanic juveniles virtually disappear for 4 years (Musick and Limpus, 1997). Their requirements for gelatinous prey suggest that they may search for areas of major upwelling. Juvenile (as well as adult) leatherbacks recruit seasonally to temperate and boreal coastal habitats to feed on concentrations of jellyfish (Lutcavage and Lutz, 1986). In the western North Atlantic, juveniles appear in these habitats at a body length of 110-120 cm (Musick and Limpus, 1997).

3.2.6.2. Presence and Abundance within the Biological Assessment Area

Leatherbacks are found throughout the BA Area in certain seasons. Leatherback turtles were frequently sighted and stranded in Chesapeake Bay during 1979 through 1997, mainly from May-September (Coles, 1999). Off South Carolina, leatherbacks have been reported primarily from April-June when "cannonball" jellyfish (*Stomolophus meleagris*) are abundant, and again in October and November (SCDNR, 2005b). It is also likely that post-hatchling and oceanic juvenile leatherbacks may be present within both offshore and coastal waters of the BA Area.

3.2.6.3. Critical Habitat

There is no designated critical habitat for the leatherback within the BA Area. Critical habitat was initially designated in 1979 (*Federal Register*, 1979) within specific areas off the U.S. Virgin Islands and St. Croix. In February 2010, the NMFS and FWS were petitioned to revise critical habitat to include specified areas off San Miguel, Paulinas, and Convento Beaches in the Northeast Ecological Corridor of Puerto Rico (Sierra Club, 2010). In July 2010, the NMFS concluded that the petition did not warrant revision of the critical habitat (*Federal Register*, 2010e).

3.2.7. Sea Turtle Hearing Capabilities

Few studies have examined the role acoustic cues play in the ecology of sea turtles (Mrosovsky, 1972; Samuel et al., 2005; Nunny et al., 2008). There is evidence that sea turtles may use sound to communicate, but the few vocalizations described for sea turtles are restricted to the “grunts” of nesting females (Mrosovsky, 1972). These sounds are low frequency and relatively loud, thus leading to speculation that nesting females use sounds to communicate with conspecifics (Mrosovsky, 1972). Very little is known about the extent to which sea turtles use their auditory environment. The acoustic environment for sea turtles changes with each ontogenetic habitat shift. In the inshore environment where juvenile and adult sea turtles generally reside, the ambient environment is noisier than the open ocean environment of the hatchlings; this inshore environment is dominated by low frequency sound (Hawkins and Myrberg, 1983) and, in highly trafficked areas, virtually constant low frequency noises from shipping and recreational boating (Hildebrand, 2009).

Much of the research on the hearing capacity of sea turtles is limited to gross morphological dissections (Wever, 1978; Lenhardt et al., 1985). Based on the functional morphology of the ear, it appears that sea turtles receive sound through the standard vertebrate tympanic middle ear path. The sea turtle ear appears to be a poor receptor for aerial sounds but is well adapted to detect underwater sound. The dense layer of fat under the tympanum acts as a low-impedance channel for underwater sound. Furthermore, the retention of air in the middle ear of these sea turtles suggests that they are able to detect sound pressures.

Electrophysiological studies on hearing have been conducted on juvenile green turtles (Ridgway et al., 1969; Bartol and Ketten, 2006), juvenile Kemp’s ridley turtles (Bartol and Ketten, 2006), and juvenile loggerhead turtles (Bartol et al., 1999; Lavender et al., 2010, 2011). Electrophysiological responses, specifically auditory evoked potentials (AEPs), are the most widely accepted technique for measuring hearing in situations in which normal behavioral testing is impractical. Most AEP research has concentrated on responses occurring within the first 10 milliseconds (ms) following presentation of a click or brief tone, which has been termed the auditory brainstem response (ABR).

Ridgway et al. (1969) measured AEPs of green turtles using both aerial and vibrational stimuli. Green turtles detect a limited frequency range (200-700 Hz) with best sensitivity at the low tone region of about 400 Hz. Though this investigation examined two separate modes of sound reception (i.e., air and bone conduction), sensitivity curves were relatively similar, suggesting that the inner ear is the main structure for determining frequency sensitivity. To measure electrophysiological responses to sound stimuli, Bartol et al. (1999) collected ABRs from juvenile loggerhead turtles. Thresholds were recorded for both tonal and click stimuli. Best sensitivity was found in the low frequency region of 250-1,000 Hz. The decline in sensitivity was rapid above 1,000 Hz, and the most sensitive threshold tested was at 250 Hz. More recently, Bartol and Ketten (2006) collected underwater ABRs from hatchling and juvenile loggerhead and juvenile green turtles using speakers suspended in air while the turtle’s tympanum remained submerged. All turtles tested responded to sounds in the low frequency range, from at least 100 Hz (lowest frequency tested) to no greater than 900 Hz. The smallest turtles tested, hatchling loggerheads, had the greatest range of hearing (100-900 Hz), while the larger juveniles responded to a much narrower range (100-400 Hz). Hearing sensitivity of green turtles also varied with size; smaller greens had a broader range of hearing (100-800 Hz) than that detected in larger subjects (100-500 Hz). Using underwater speakers as a sound source, Lavender et al. (2010, 2011) measured underwater AEPs in loggerhead turtles ranging from yearlings to subadults and detected responses to frequencies between 50 and 1,000 Hz.

3.3. BIRDS

3.3.1. Introduction

Under the ESA, there are three threatened or endangered species of marine and coastal birds within the BA Area: roseate tern, piping plover, and Bermuda petrel (or cahow) (USDOI, FWS, 2011a). In addition, there is one “Priority 3” candidate species, the red knot. Candidate species are identified by the FWS as species for which sufficient information is available to support a proposal to list as endangered or threatened, but for which preparation and publication of a proposal is precluded by higher priority listing actions (*Federal Register*, 2006). The red knot is also protected under the Federal Migratory Bird Treaty Act (50 CFR 10.13).

Piping plover and red knot are shorebirds that are unlikely to come into contact with G&G activities. Roseate terns are more likely to come into contact with G&G 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 BA Area but feeds by snatching prey from the sea surface.

3.3.2. Roseate Tern (*Sterna dougallii*)

3.3.2.1. Species Overview

The roseate tern is a medium-sized tern. It is a worldwide species that is divided into five subspecies. The Atlantic subspecies (*S. dougallii dougallii*) breeds in two discrete areas in the western hemisphere (USDOI, FWS, 1998); these are recognized as separate populations, the northeastern and Caribbean populations. The northeastern population, which is endangered, breeds from New York north to Maine and into adjacent areas of Canada. However, historically this population bred as far south as Virginia, and this state is recognized as the southern extent of breeding by USDOI, FWS (2011b). The Caribbean population breeds on islands around the Caribbean Sea from the Florida Keys to the Lesser Antilles; this population, which is listed as threatened, also occurs along the U.S. southeast coast, where there are occasional breeding records from North Carolina, South Carolina, and Georgia (USDOI, FWS, 2011b).

The roseate tern Atlantic subspecies *S. d. dougallii* is thought to migrate through the eastern Caribbean and along the north coast of South America, and to winter mainly on the east coast of Brazil (USDOI, FWS, 2011b). The primary reason for the initial listing of the roseate tern was the concentration of the population into a small number of breeding sites; in 1998, about 85 percent nested in three colonies (USDOI, FWS, 1998). To a lesser extent, declines in population contributed to their listing, with approximately 3,400 breeding pairs in 1997 (USDOI, FWS, 1998). The most important factors in breeding colony loss were encroachment by herring gulls and/or great black-backed gulls and habitat loss.

Roseate terns are primarily pelagic along seacoasts, bays, and estuaries, going to land only to nest and roost (Sibley, 2000). They breed in colonies almost exclusively on small offshore islands, rarely on large islands. The northeastern colonies are on rocky offshore islands, barrier beaches, or salt marsh islands. They hide their nests by nesting in dense vegetation, rocks, driftwood, and even tires or wooden boxes. Most colonies are close to shallow water fishing sites with sandy bottoms, bars, or shoals. They forage offshore and roost in flocks, typically near tidal inlets in late July to mid-September. Along the Atlantic coast, they nest on islands on sandy beaches, open bare ground, and grassy areas, typically near areas with cover or shelter (Nature Serve, InfoNatura, 2011).

Roseate terns forage mainly by plunge-diving and contact-dipping or surface dipping over shallow sandbars, reefs, or schools of predatory fish. They are adapted for fast flight and relatively deep diving and often submerge completely when diving for fish (USDOI, FWS, 2011b).

3.3.2.2. Presence and Abundance within the Biological Assessment Area

The two populations of the roseate tern subspecies *S. d. dougallii* may occur within the BA Area. It is believed that this species will occur in relatively low numbers since the primary nesting areas are in Buzzards Bay, Massachusetts; Great Gull Island, New York; and in the northern Gulf of Maine (USDOI, FWS, 1998).

3.3.2.3. Critical Habitat

No critical habitat has been designated for the roseate tern.

3.3.3. Bermuda Petrel (*Pterodroma cahow*)

3.3.3.1. Species Overview

The Bermuda petrel (or cahow, as it is known locally on Bermuda) is a member of the gadfly petrel group (Genus *Pterodroma*), which are highly pelagic birds widespread in tropical and subtropical seas (Warham, 1990; Brooke, 2004). The Bermuda petrel and other gadfly petrels are usually colonial when breeding but are often solitary at sea, feeding within oceanic waters on surface and near-surface prey. They are extremely aerial birds and rarely land on the sea (Warham, 1990).

Bermuda petrels feed by snatching food or "dipping," or by scavenging dead or dying prey floating on or near the sea surface (Warham, 1990). They and other gadfly petrels are known to feed at night, primarily on squids but also on fishes and invertebrates to a lesser degree. Studies on other gadfly petrels found that their prey consisted of species associated with deep scattering layers (Warham, 1996).

The Bermuda petrel is a Bermuda endemic species that breeds on rocky inlets in Castle Harbour and on Nonsuch Island, Bermuda (October-June) (Warham, 1990; Onley and Scofield, 2007). It was believed to be extinct in the 1620's; however, 18 breeding pairs were found on rocky islets in Castle Harbour in 1951 and an extensive conservation program has developed. The species' distribution outside of the breeding season is poorly known, though it is probably widespread in the North Atlantic, following the warm waters on the western edges of the Gulf Stream.

Exploitation of nesting Bermuda petrels by early colonists and predation by introduced mammals decimated their numbers. They were initially listed by FWS as endangered in 1970 (USDOI, FWS, 2011c). Successful conservation efforts have increased the population, but it remains listed as endangered (*Federal Register*, 2007).

3.3.3.2. Presence and Abundance within the Biological Assessment Area

There are confirmed sightings of Bermuda petrels offshore of North Carolina (Lee, 1984, 1987). From these sightings data, it is presumed that this species may occur within offshore waters of the BA Area, although their presence in this area is probably rare.

3.3.3.3. Critical Habitat

No critical habitat has been designated for the Bermuda petrel.

3.3.4. Piping Plover (*Charadrius melodus*)

3.3.4.1. Species Overview

The piping plover is a small, migrant shorebird that breeds on beaches from Newfoundland to North Carolina (and occasionally south to South Carolina) and winters along the Atlantic coast from North Carolina south, along the Gulf Coast, and in the Caribbean (USDOI, FWS, 1996). Piping plovers that breed on the Atlantic coast belong to the subspecies *Charadrius melodus melodus* (USDOI, FWS, 2009). The Atlantic coast population is classified as threatened, whereas other piping plover populations inhabiting the Northern Great Plains and Great Lakes watersheds are endangered (USDOI, FWS, 2011d).

A key threat to the Atlantic coast population of the piping plover is habitat loss due to shoreline development (USDOI, FWS, 1996). Piping plovers are very sensitive to human activities, and disturbances from anthropogenic activities can cause the parent birds to abandon their nests. Since the listing of this species under the ESA in 1986, the Atlantic coast piping plover population has increased 234 percent, from approximately 790 breeding pairs to an estimated 1,849 pairs in 2009 (USDOI, FWS, 2009). Although increased abundance has reduced near-term vulnerability to extinction, piping plovers remain sparsely distributed across their Atlantic coast breeding range, and populations are highly vulnerable to even small declines in survival rates of adults and fledged juveniles (USDOI, FWS, 2009).

Piping plovers inhabit coastal sandy beaches and mudflats. They use open, sandy beaches close to the primary dune of the barrier islands for breeding, preferring sparsely vegetated open sand, gravel, or cobble for a nest site. They feed on marine worms, fly larvae, beetles, insects, crustaceans, mollusks, and other small invertebrates. They forage along the wrack zone, or line, where dead or dying seaweed, marsh grass, and other debris is left on the upper beach by the high tide (USDOI, FWS, 2011d).

3.3.4.2. Presence and Abundance within the Biological Assessment Area

Piping plovers may occur on beaches and flats throughout the BA Area, primarily in the winter (**Figure A-14**).

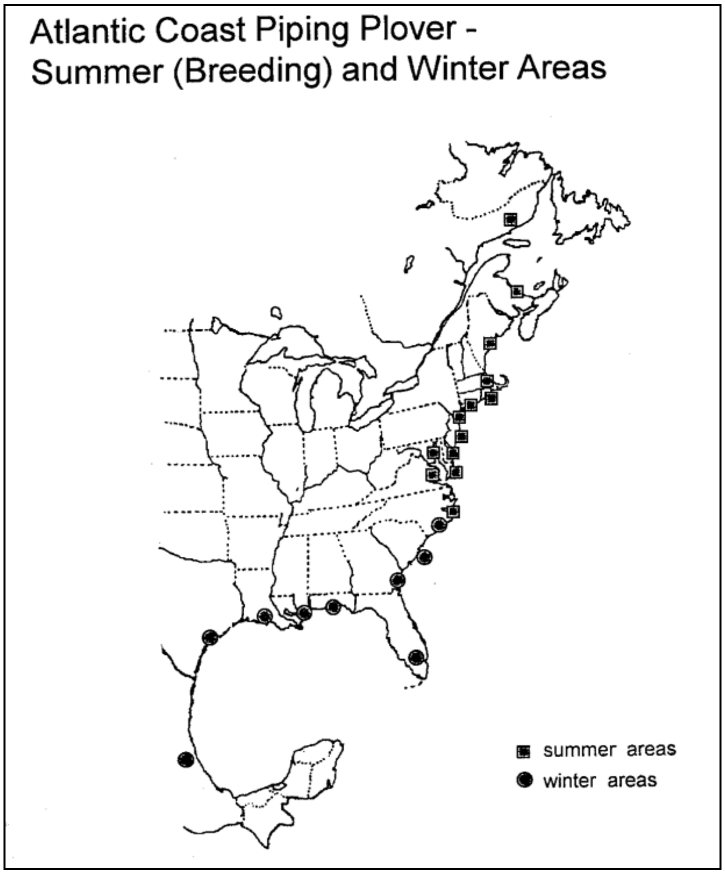


Figure A-14. Locations of Winter and Summer Congregations of Piping Plovers. Source: USDOI, FWS (2012).

3.3.4.3. Critical Habitat

The FWS first designated critical habitat for the wintering population of piping plovers in 142 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas on July 10, 2001 (*Federal Register*, 2001). Critical habitat areas were subsequently revised in North Carolina in 2008 (*Federal Register*, 2008) and in Texas in 2009 (*Federal Register*, 2009).

3.3.5. Red Knot (*Calidris canutus*)

3.3.5.1. Species Overview

The red knot is a medium-sized shorebird that migrates in large flocks long distances between breeding grounds in mid- and high-Arctic areas and wintering grounds in southern South America (USDOI, FWS, 2010a), flying more than 14,967 km (9,300 mi) from south to north, making this bird one of the longest-distance migrants in the animal kingdom. Along the Mid-Atlantic and southeastern coasts, red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks (USDOI, FWS, 2010a). In Delaware Bay, they feed primarily on horseshoe crab eggs, and the timing of their arrival within the bay typically coincides with the annual peak of the horseshoe crab spawning period (USDOI, FWS, 2010a).

This species was added to the list of candidate species under the ESA in September 2006 (*Federal Register*, 2006). Surveys at wintering areas and in Delaware Bay during spring migration indicated a substantial decline in the red knot population in recent years (USDOI, FWS, 2010a,b). The primary threat to the red knot is a decrease in the availability of horseshoe crab eggs, since horseshoe crabs are harvested primarily for use as bait and secondarily to support a biomedical industry (USDOI, FWS, 2010a,b). Other identified threat factors include habitat destruction due to beach erosion and various shoreline protection and stabilization projects, the inadequacy of existing regulatory mechanisms, human disturbance, and competition with other species for limited food resources.

Red knots migrate northward through the contiguous U.S. in April-June and southward in July-October. Delaware Bay is the most important spring migration stopover in the eastern U.S. because it is the final stop at which the birds can refuel in preparation for their nonstop leg to the Arctic (USDOI, FWS, 2010a; NatureServe, InfoNatura, 2011). Approximately 90 percent of the entire population of red knot can be present in Delaware Bay in a single day (USDOI, FWS, 2010a). In addition to the large flocks traditionally found in Delaware Bay, flocks of up to 6,000 red knots have been observed from Georgia to Virginia in recent years (USDOI, FWS, 2010a).

3.3.5.2. Presence and Abundance within the Biological Assessment Area

Red knots may occur on beaches and flats throughout the BA Area, primarily as stopovers during spring and fall migrations. No nesting or breeding occurs in the BA Area, as red knots breed in the central Canadian Arctic (USDOI, FWS, 2010a).

3.3.5.3. Critical Habitat

No critical habitat has been designated for the red knot.

3.4. FISHES

3.4.1. Introduction

Three fish species presently listed as endangered under the ESA are known to occur within the BA Area: smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon. On November 2, 2011, the NMFS announced that two anadromous species – the alewife (*Alosa pseudoharengus*) and the blueback herring (*Alosa aestivalis*) – were undergoing a status review to be listed as threatened (*Federal Register*, 2011d). Both of these species occur in the BA Area as adults and are currently “candidate” species for listing under ESA.

3.4.2. Smalltooth Sawfish (*Pristis pectinata*)

3.4.2.1. Species Overview

Despite their elongated, shark-like appearance, sawfishes (Family Pristidae) actually are more closely related to skates and rays (Suborder Batoidei). Sawfishes get their name from their “saws,” which are long, flat snouts edged with pairs of teeth that are used to locate, stun, and kill prey. Seven species of sawfishes are found in shelf, coastal, estuarine, and riverine waters worldwide, and all are imperiled (USDOC, NMFS, 2006). Two species occur in the western Atlantic: largetooth sawfish (*Pristis perotteti)* and smalltooth sawfish (*Pristis pectinata*) (McEachran and de Carvalho, 2002). The smalltooth sawfish was listed as endangered in 2003 after NMFS was petitioned by the Ocean Conservancy (*Federal Register*, 2003). In 2009, smalltooth sawfish critical habitat was delineated and published (74 CFR 45353).

The smalltooth sawfish historically occurred throughout the Gulf of Mexico and north to Long Island Sound on the east coast. This range has greatly receded over the past 200 years, leaving a single DPS in southwest Florida, which is where the critical habitat has been designated for this species (**Figure A-15**).

The smalltooth sawfish normally inhabits shallow waters (10 m [33 ft] or less) often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters (~70 m [230 ft]) of the continental shelf. Shallow water less than 1 m (3 ft) appears to be an important nursery area for young smalltooth sawfish, particularly in areas where mangrove trees are present.

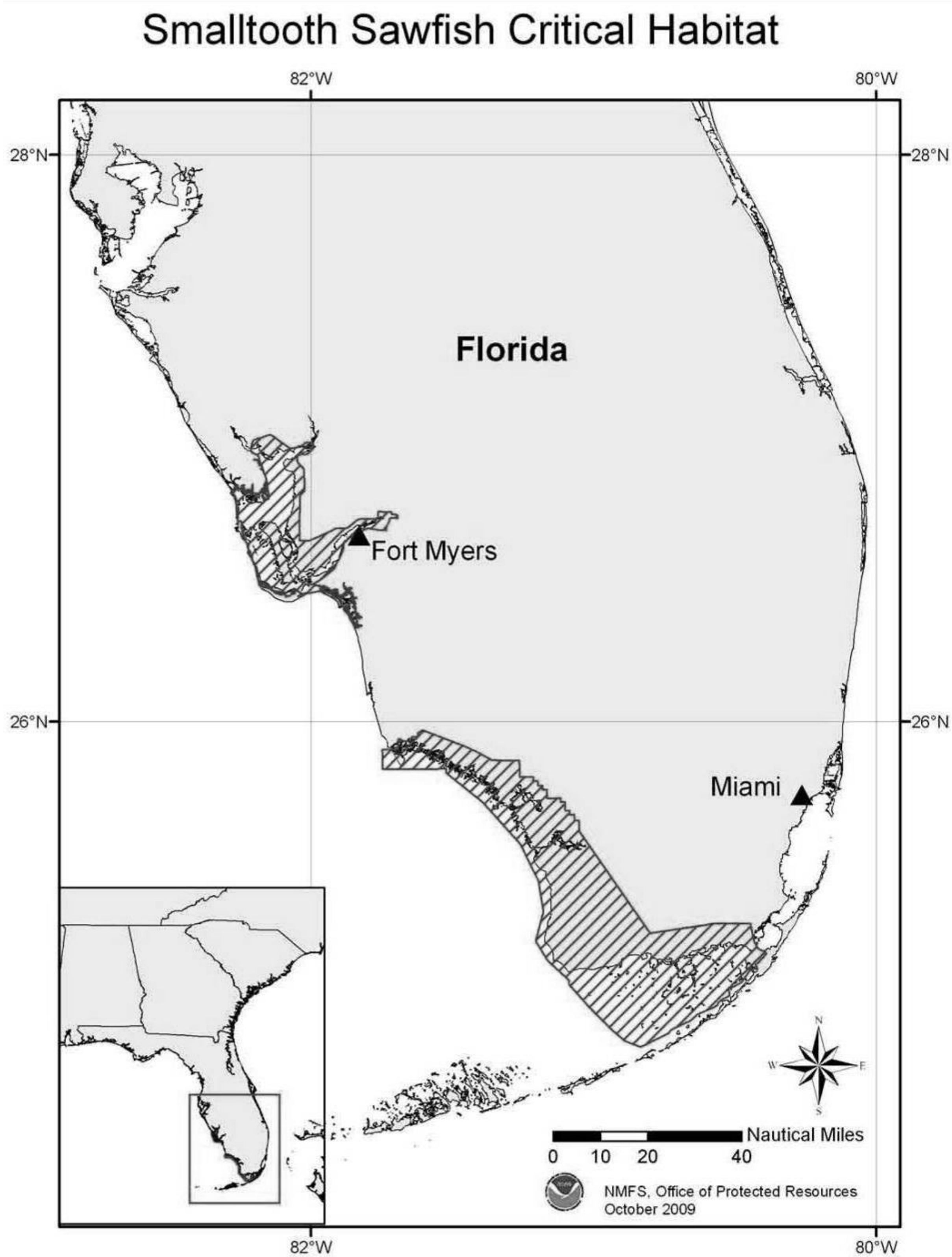


Figure A-15. Location of Critical Habitat for the Smalltooth Sawfish. Source: USDOC, NMFS (2011f).

Smalltooth sawfish reproduce by internal fertilization. Males mature between 10 and 20 years at an average size of 253-351 cm (8.3-11.5 ft) total length. Size and age at maturity is not known for females (USDOC, NMFS, 2009a, 2011e). Females bear live young, and litters reportedly range from 15-20 embryos requiring a year of gestation (USDOC, NMFS, 2009a). Smalltooth sawfish grow to a maximum size of 7.6 m (24.7 ft) an age of 60 years. Coarse estimates of growth rates show that early juveniles grow rapidly during the first 2 years then slow considerably.

Smalltooth sawfish feed on benthic invertebrates and fishes. The saw has been considered as a trophic apparatus, used to herd and even impale shallow-water schooling fishes such as herrings and mullets (Breder, 1952). It appears more likely that the saw is used to rake the seafloor to uncover partially buried invertebrates.

Small juvenile sawfishes may be susceptible to predation from bull sharks (*Carcharhinus leucas*) and lemon sharks (*Negaprion brevirostris*) that inhabit similar water depths as the smalltooth sawfish. The toothed saw of fish of all sizes will readily entangle in nets, ropes, monofilament line, discarded pipe sections, and other debris (Seitz and Poulakis, 2006). Some sawfishes are caught incidentally on hook and line by fishers seeking sharks, tarpon, or groupers, and though most are released unharmed, many of these interactions will result in death of the individual. There was and may still be some incentive to collect the saws as curios, but this has not been well documented.

3.4.2.2. Presence and Abundance within the Biological Assessment Area

The current distribution and abundance of smalltooth sawfish are centered along the coast of southwest Florida (USDOC, NMFS, 2009a). Historically, smalltooth sawfish were supported year-round in the BA Area as far north as northern Florida, but north of Florida they were seasonal visitors (Bigelow and Schroeder, 1953). Population status in areas north of southern Florida is virtually unknown. A search of the National Sawfish Encounter Database (Simpfendorfer and Wiley, 2006) managed by the Florida Museum of Natural History Sawfish Implementation Team revealed only two recent sightings of smalltooth sawfish in the BA Area (**Figure A-16**): one off Florida, and another from Georgia reported by a bottom longline fishery observer who documented the capture of an estimated 4.0-m (13-ft) adult from depths of 45.6-72.6 m (152-242 ft).

3.4.2.3. Critical Habitat

Presently the core of the smalltooth sawfish DPS is surviving and reproducing in the waters of southwest Florida and Florida Bay, primarily within the jurisdictional boundaries of Everglades National Park, where important habitat features are still present and less fragmented than other parts of the historic range (Simpfendorfer and Wiley, 2005; USDOC, NMFS, 2009a). This area also encompasses the critical habitat as listed in Federal regulations (74 CFR 45353).

3.4.3. Shortnose Sturgeon (*Acipenser brevirostrum*)

3.4.3.1. Species Overview

The shortnose sturgeon belongs to the family Acipenseridae and is one of several members of the family found exclusively in North America. This species was originally listed as endangered on March 11, 1967 (*Federal Register*, 1967) under the Endangered Species Preservation Act of 1966. Subsequently, NMFS prepared a recovery plan for the species under the ESA (*Federal Register*, 1998b), and at present 19 east coast rivers are considered to support DPSs (**Figure A-17**) (USDOC, NMFS, 1998b). Population declines were attributed to habitat loss or alteration, pollution, and incidental capture in nets set for other species.

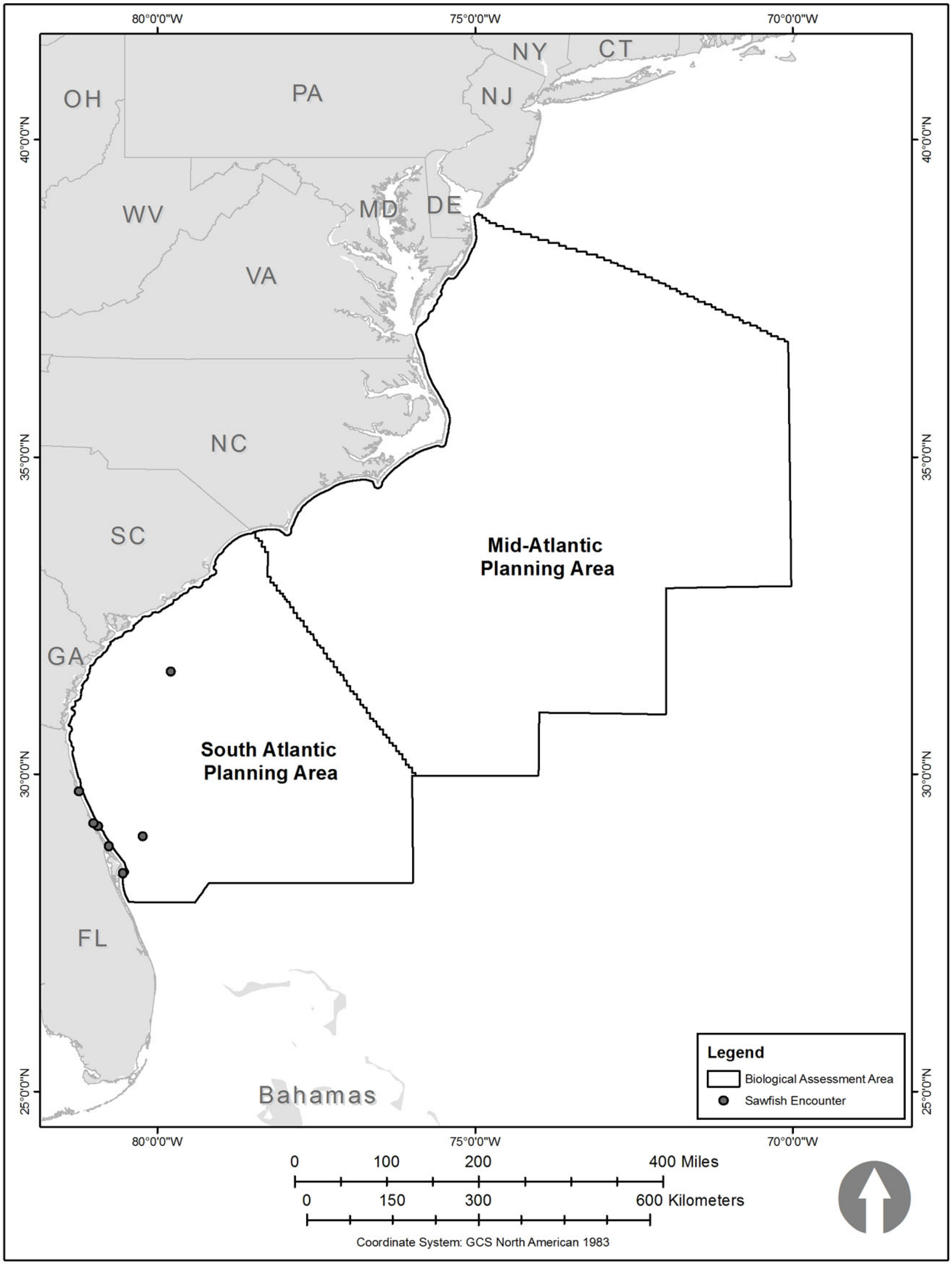


Figure A-16. Locations of All Smalltooth Sawfish Sightings Recorded from 1999-2009.
Source: National Sawfish Encounter Database (2011).

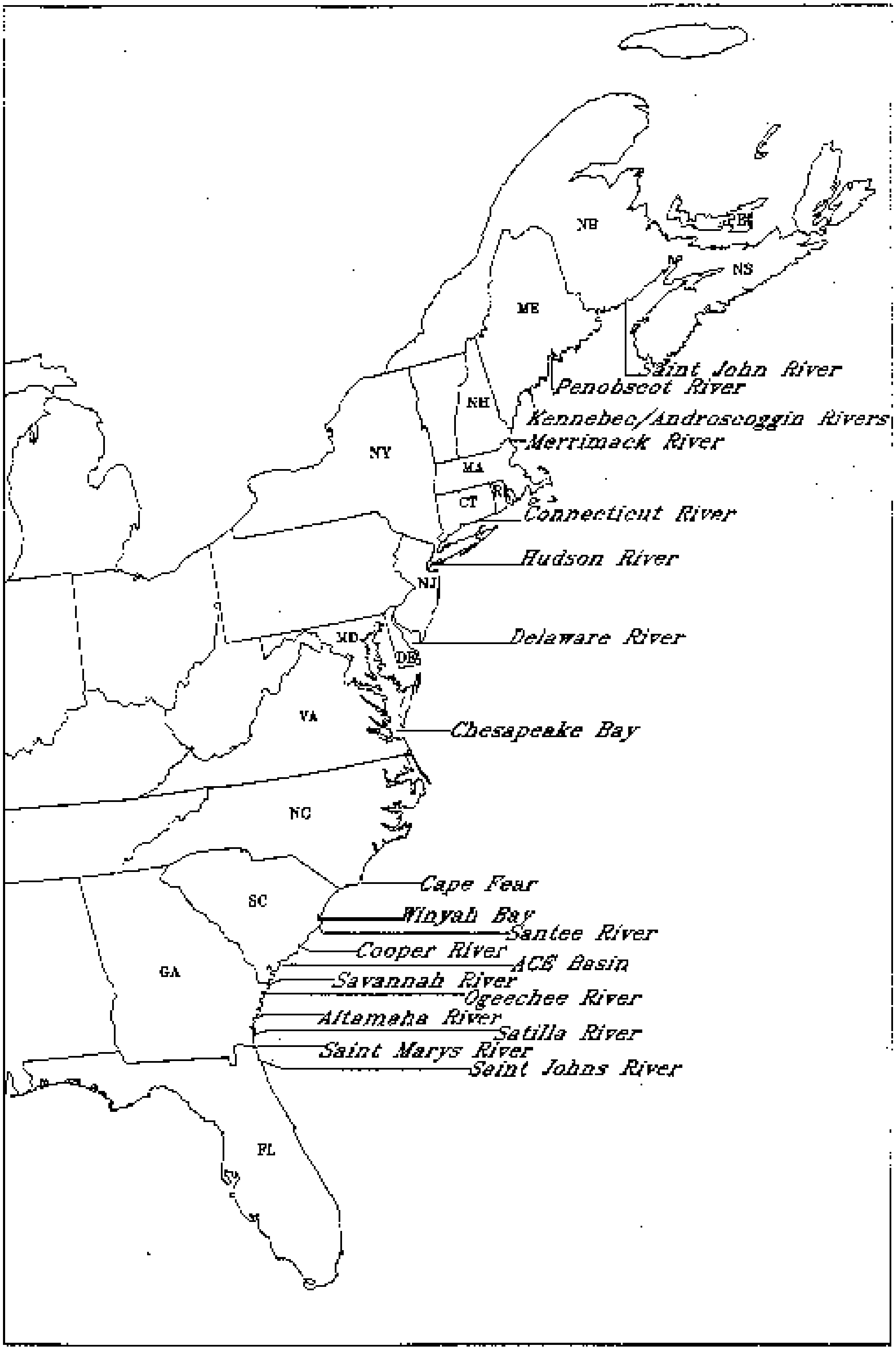


Figure A-17. Locations of Distinct Population Segments for the Shortnose Sturgeon. Source: USDOC, NMFS (1998b).

Shortnose sturgeon use of saltwater is generally amphidromous throughout most of the species' range, although far northern populations are anadromous. Spawning takes place in upper freshwater areas, while feeding (summering) and wintering occurs in both fresh and saline environments. This species typically spends its entire life history in the natal river and estuary and only rarely moves any great distance in near-coastal marine waters. The shortnose sturgeon is found in larger rivers and estuaries of the North America eastern seaboard from the St. Johns River in Florida to the St. Johns River in Canada. Adults ascend rivers to spawn from February-April; eggs are deposited over hard bottom, in shallow, fast-moving water (Dadswell et al., 1984; Murdy et al., 1997). Fecundity ranges from 27,000-208,000 eggs per female (Murdy et al., 1997). Growth is relatively slow, with females reaching maturity in 6-7 years whereas males mature in 3-5 years. Shortnose sturgeon can live to be over 67 years, with an average life span of 30-40 years.

3.4.3.2. Presence and Abundance within the Biological Assessment Area

The shortnose sturgeon is primarily an estuarine and riverine species and rarely enters the coastal ocean of the BA Area. Most of the river systems where DPSs exist are in North Carolina, South Carolina, Georgia, and northern Florida (USDOC, NMFS, 1998b). Although these systems drain into the estuaries or the coastal ocean portion of the BA Area, shortnose sturgeon have rarely been found in coastal or shelf waters (Dadswell et al., 1984; Moser and Ross, 1995; Collins and Smith, 1997). Collins and Smith (1997) reviewed available records and reported 39 individuals ranging from 60-100 cm (2-3.3 ft) total length caught offshore of South Carolina from January-March. Dadswell et al. (1984) reported eight records from the Atlantic Ocean between Cape Henry, Virginia, and Cape Fear, North Carolina.

3.4.3.3. Critical Habitat

Critical habitat has not been designated for individual shortnose sturgeon DPSs due to lack of population-specific data (USDOC, NMFS, 1998b).

3.4.4. Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)

3.4.4.1. Species Overview

The Atlantic sturgeon is a member of the family Acipenseridae. Atlantic sturgeon co-occurs with shortnose sturgeon (see **Section 3.4.3**) in some habitats and utilizes coastal rivers, estuaries, and the continental shelf during its ontogeny.

The National Resources Defense Council (NRDC) petitioned NMFS to list the Atlantic sturgeon as endangered (NRDC, 2009). The NRDC requested that the species be segregated into five separate DPSs, including the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic (**Figure A-18**). On February 6, 2012, the NMFS issued final rules classifying the Gulf of Maine DPS as threatened and the other four DPSs as endangered (*Federal Register*, 2012b,c). Based on information provided in the NMFS final rule, the four endangered DPSs (New York Bight, Chesapeake Bay, Carolina, and South Atlantic) could be represented within the BA area.

The Atlantic sturgeon is an anadromous species that resides in 32 coastal rivers of North America from the St. Johns River in Florida northward to Hamilton Inlet, Labrador. Spawning occurs in the freshwater reaches of 14 of these 32 rivers. The Atlantic sturgeon uses estuarine and marine waters primarily during fall and winter months then ascends the spawning rivers from March-April. Mature females produce between 400,000 and 8,000,000 adhesive eggs that attach to gravel or other hard substrata on the river bed. Larvae develop as they move downstream to the estuarine portion of the spawning river where they reside as juveniles for 2-6 years. Adults live for up to 60 years. Age at maturity varies with subpopulation but ranges from 5-10 years in South Carolina to 22-34 years in the St. Lawrence River, Canada.

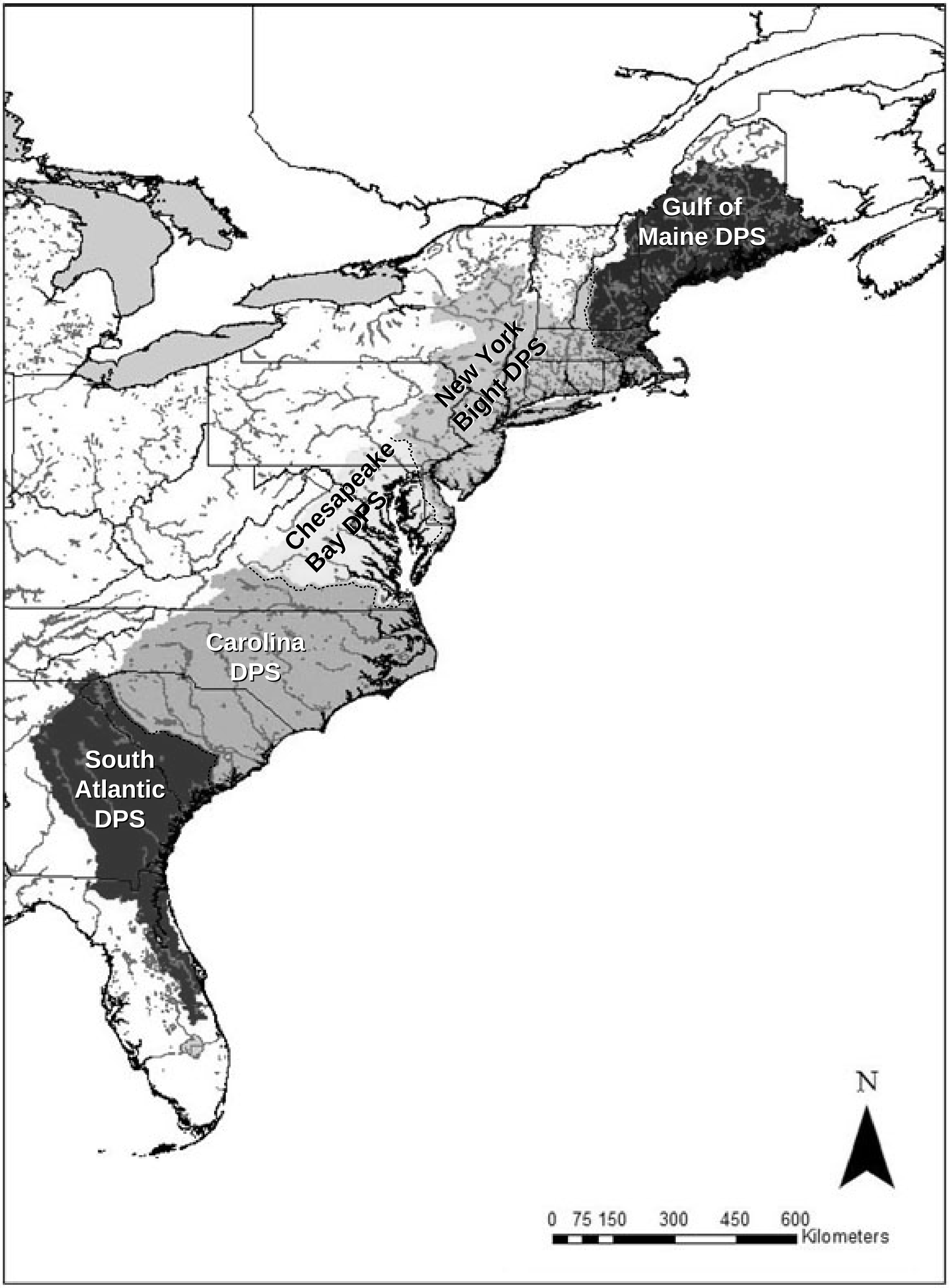


Figure A-18. Locations of Distinct Population Segments (DPSs) for the Atlantic Sturgeon (From: Atlantic Sturgeon Status Review Team, 2007).

Atlantic sturgeon are generally slow growing and late maturing, and mature individuals may not spawn every year (generally 1-5 years between spawning events). Spawning takes place in flowing freshwater. Subadults will move into coastal ocean waters where they may undergo extensive movements usually confined to shelly or gravelly bottoms in 10-50 m (33-164 ft) water depths (Stein et al., 2004). Areas of particular concentration were identified by Laney et al. (2007) as offshore (water depth between 9.1 and 21.3 m [30 and 70 ft]) of Virginia and near sand shoals adjacent to Oregon Inlet, North Carolina. Populations from several rivers will intermingle in shelf waters, eventually returning to their natal rivers to spawn.

3.4.4.2. Presence and Abundance within the Biological Assessment Area

Adult and subadult Atlantic sturgeon occur in the shelf waters of the BA Area during fall and winter months. Evidence from extensive tagging programs using trawl-caught fish indicate that shelf areas less than 21.3 m (70 ft) deep offshore of Virginia and North Carolina support concentrations of Atlantic sturgeon during fall and winter months (Laney et al., 2007; Dunton et al., 2010). Data are lacking for areas south of Cape Hatteras. Satellite tracking confirmed the depth preferences and geographic areas generated from conventional trawl gear (Erickson et al., 2011). Based on their size, most of the individuals caught within the BA Area were immature or subadult fish (Stein et al., 2004; Laney et al., 2007).

3.4.4.3. Critical Habitat

Critical habitat has not been designated for Atlantic sturgeon.

3.4.5. Alewife (*Alosa pseudoharengus*)

3.4.5.1 Species Overview

On August 5, 2011, the NMFS was petitioned by the NRDC requesting that the alewife (*Alosa pseudoharengus*) be listed as threatened under the ESA as four DPSs: Central New England, Long Island Sound, Chesapeake Bay, and Carolina. The NMFS published the proposed listing in the *Federal Register* on November 2, 2011 (*Federal Register*, 2011d).

3.4.5.2. Presence and Abundance with the Biological Assessment Area

The alewife is found along the coast of eastern North America from the Gulf of St. Lawrence to South Carolina (Kells and Carpenter, 2011). Abundance of alewives as indicated by fishery landings has peaked during the late 1950's and has steadily declined since that time (USDOC, NMFS, 2009b). Specific causes of the decline have not been determined; however, overfishing and loss of riverine spawning habitat are likely candidates.

The alewife is an anadromous species that resides in the ocean for most of its adult life but spawns in freshwater reaches of coastal rivers within its geographical range. During fall and winter, most of the population overwinters in coastal waters of the continental shelf. Alewives were most abundant in 184 to 361 ft (56 to 110 m) water depths (Neves, 1981). In spring (March through May) when water temperatures reach 46-54°F (8-12°C), mature adults averaging between 3 and 4 years of age enter coastal rivers and migrate to freshwater to spawn (Scott and Scott, 1988). Females produce between 48,000 and 360,000 eggs that are fertilized in the water column. The eggs are adhesive and will stick to vegetation and other substrata. Eggs hatch after about 3-5 days. Young make their way downstream, concentrating in estuaries where they grow rapidly durng the first year (Scott and Scott, 1988). After spawning, the adults return to the sea where they feed on a variety of planktonic organisms.

3.4.5.3. Critical Habitat

Critical habitat has not been designated for the alewife.

3.4.6. Blueback Herring (*Alosa aestivalis*)

3.4.6.1 Species Overview

On August 5, 2011, the NMFS was petitioned by the NRDC requesting that the blueback herring be listed as threatened under the ESA throughout much of its geographic range. The NRDC requested that the species be segregated into three DPSs: Central New England, Long Island Sound, and Chesapeake Bay. The NMFS published the proposed listing in the *Federal Register* on November 2, 2011 (*Federal Register*, 2011d).

3.4.6.2 Presence and Abundance with the Biological Assessment Area

The blueback herring is found from Nova Scotia to the St. Johns River in northern Florida (Kells and Carpenter, 2011). Blueback herring abundance in the BA Area as indicated by fishery landings has dropped since the late 1950's. Reasons for the decline are assumed to include overfishing (including incidental landings by mid-water trawl fisheries) and habitat degredation (particularly for spawning rivers) (USDOC, NMFS, 2009b).

The blueback herring is an anadromous species that lives in the marine environment but ascends freshwater rivers to spawn. Adults occur primarily in coastal and inner shelf waters but also occur over the outer shelf. In shelf waters, preferred depth range for adults is 88-180 ft (27-55 m) (Neves, 1981). During summer, the greastest abundances were recorded from Georges Bank and Nantucket Shoal. In winter, adults are distributed from Cape Hatteras to the Gulf of Maine (Neves, 1981). The blueback herring is a coastal migratory pelagic that forms large schools and feeds on plankton. These schools undergo vertical migration in response to water temperature and plankton productivity. Water temperature initiates spawning migrations, which generally occur from March-May. Mature fish enter rivers when water temperatures drop to between 41 and 50°F (5 and 10°C). Evidence suggests that individual fish return to natal rivers to spawn. Spawning takes place in moving freshwaters, generally over hard substrate. Young reside in fresh or brackish waters including ponds and lakes with access to the ocean (Loesch and Lund, 1977).

3.4.6.3. Critical Habitat

Critical habitat has not been designated for the blueback herring.

3.4.7. Fish Hearing Capabilities

Sound plays a major role in the lives of all fishes (e.g., Zelick et al., 1999; Fay and Popper, 2000). This is particularly the case since sound travels much farther in water than other potential signals, and it is not impeded by darkness, currents, or obstacles in the environment. Thus, fishes can glean a great deal of information about biotic (living) and abiotic (environmental) sources and get a good "image" of the environment (Fay and Popper, 2000; Popper et al., 2003; Slabbekoorn et al., 2010).

In addition to listening to the overall environment and being able to detect sounds of biological relevance (e.g., sounds produced by swimming predators), many species of bony fishes (but not elasmobranchs, a group that includes the smalltooth sawfish) communicate with sounds and use sounds in a wide range of behaviors including, but not limited to, mating and territorial interactions (see Zelick et al., 1999 for review). Consequently, anything that impedes the ability of fishes to hear biologically relevant sounds such as those produced by anthropogenic sound sources could interfere with normal behaviors. Much more detailed discussions of all aspects of fish bioacoustics can be found in Fay and Megala-Simmons (1999), Zelick et al. (1999), Popper et al. (2003), and Webb et al. (2008). A broad discussion of interactions of anthropogenic sounds and fishes can be found in Popper and Hastings (2009a,b) and Popper and Hawkins (2011).

Besides being able to detect sounds, a critical role for hearing is to be able to discriminate between different sounds (e.g., frequency and intensity), detect biologically relevant sounds in the presence of background noises (called maskers), and determine the direction and location of a sound source in the space around the animal. While actual data on these tasks are available for only a few fish species, all species are likely to have similar capabilities (reviewed in Fay and Megela-Simmons, 1999; Popper et al., 2003; Fay, 2005).

Sensory hair cells in fishes, as in mammals (including humans), can be damaged or killed by exposure to very loud sounds (Le Prell et al., 2011). In humans, sensory cells that die are not replaced, resulting in deafness, whereas fishes are able to repair and replace cells that die (Lombarte et al., 1993; Smith et al., 2006). Moreover, whereas in humans the ear has its full complement of sensory hair cells at birth, fishes continue to produce sensory hair cells for much of their lives, resulting in an increase in sensory hair cells as they age (Popper and Hoxter, 1984; Lombarte and Popper, 1994). Because fishes have the ability to repair damaged sensory hair cells and continuously increase their number, they are not likely to become permanently deaf. There is some chance of temporary hearing loss, but this is quickly repaired (Smith et al., 2006), and there is no evidence in fishes for permanent hearing loss.

Basic data on hearing provide information about the range of frequencies that a fish can detect and the lowest sound level that an animal is able to detect at a particular frequency. Hearing thresholds have been determined for perhaps 100 species (Fay, 1988; Popper et al., 2003; Ladich and Popper, 2004; Nedwell et al., 2004; Ramcharitar et al., 2006; Popper and Schilt, 2008). With few exceptions, fishes cannot hear sounds above about 3-4 kHz, and the majority of species are only able to detect sounds ≤1 kHz. Most, if not all, fishes can detect sounds to below 100 Hz and likely to below 50 Hz. There have also been studies on a few species of cartilaginous fishes (a group that includes sawfishes), with results suggesting that they detect sounds to no more than 600 or 800 Hz (e.g., Myrberg et al., 1976; Myrberg, 2001; Casper et al., 2003; Casper and Mann, 2006).

The data available, while very limited, suggest that the majority of marine species do not have specializations to enhance hearing and probably rely on both particle motion and sound pressure for hearing. Hearing capabilities vary considerably between different bony fish species, and there is no clear correlation between hearing capability and environment. There is also broad variability in hearing capabilities within fish families.

Appendix J of the Draft Programmatic EIS categorizes fishes into four groups based on their hearing capabilities. Sawfishes are in Group 1, which consists of fishes that do not have a swim bladder. These fishes are likely to use only particle motion for sound detection. The highest frequency of hearing is likely to be no greater than 400 Hz, with poor sensitivity compared to fishes with a swim bladder. Sturgeons are in Group 2, which includes fishes that detect sounds from below 50 Hz to perhaps 800-1,000 Hz (though several probably detect sounds only to 600-800 Hz). These fishes have a swim bladder but no known structures in the auditory system that would enhance hearing, and sensitivity (lowest sound detectable at any frequency) is not very great. These species detect both particle motion and pressure, and the differences between species are related to how well the species can use the pressure signal.

4. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process (50 CFR 402.02).

4.1. FACTORS AFFECTING SPECIES WITHIN THE BIOLOGICAL ASSESSMENT AREA

Historical and ongoing activities that shape the environmental baseline in the BA Area include shipping and marine transportation, commercial and recreational fishing, military range complexes and civilian space program use, sand and gravel mining and beach restoration, renewable energy development, oil and gas exploration and development, liquefied natural gas (LNG) import terminals, dredging and dredged material disposal, and coastal development.

4.1.1. Shipping and Marine Transportation

Commercial, military, and recreational shipping and marine transportation is common and widespread throughout the BA Area. The passage of large commercial ships along the inner shelf is limited to shipping fairways and navigation channels that are designed to control the movement of vessels as they approach ports. Six large, commercial ports are found along the coastline adjacent to the BA Area:

- Norfolk, Virginia (Port of Virginia);
- Wilmington, North Carolina;
- Charleston, South Carolina;
- Savannah, Georgia;
- Brunswick, Georgia; and
- Jacksonville, Florida.

In addition, Delaware Bay provides access to Delaware River ports and terminals in the Wilmington, Delaware, and Philadelphia, Pennsylvania, areas. Chesapeake Bay provides access to the Port of Baltimore and numerous smaller ports in Maryland and Virginia.

Large commercial vessels (cargo ships, tankers, and container ships) use these ports to access overland rail and road routes to transport goods throughout the U.S. Other vessels using these ports include military vessels, commercial business craft (tug boats, fishing vessels, and ferries), commercial recreational craft (cruise ships and fishing/sightseeing/diving charters), research vessels, and personal craft (fishing boats, house boats, yachts and sailboats, and other pleasure craft).

The U.S. Coast Guard (USCG) designates shipping fairways and establishes traffic separation schemes that control the movement of vessels as they approach ports (33 CFR Part 166). Each of the ports is serviced by a navigation channel maintained by the COE. Traffic fairways and the buoys and beacons that serve as aids to navigation are identified on NOAA's Office of Coast Survey's navigation charts. However, smaller commercial, military, and recreational vessels may travel throughout the BA Area. In offshore waters outside of certain regulated channels, vessel speed is not regulated.

Historical and ongoing effects on listed species from shipping and marine transportation include vessel strikes; disturbance by vessel traffic and noise; accidental releases of trash and marine debris; and oil spills due to vessel collisions or other accidents.

4.1.2. Commercial and Recreational Fishing

The Mid- and South Atlantic coastal states support a regionally and nationally important commercial fishing industry (Southwick Associates, Inc., 2006; USDOC, NMFS, 2009c). **Chapters 4.2.7** and **4.2.8** of the Draft Programmatic EIS provide additional information about commercial and recreational fishing activities in the BA Area.

Commercial fisheries within the BA Area can be generally categorized into four zones according to where species can be found in the water column and distance from shore. In general, these zones are as follows:

- benthic: inshore (~4.88 km [3 mi]) to offshore (~32 km [20 mi]); species found within bottom sediments or along the seafloor;
- demersal: inshore (~4.88 km [3 mi]) to offshore (~32 km [20 mi]); species associated with the bottom (1-2 m [3.3-6.6 ft] above the seafloor) but that are not found within the bottom sediments;
- coastal pelagic: mid-water and surface (~8-32 km [5-20 mi] from shore); and
- pelagic: mid-water (mesopelagic) and surface (epipelagic); >64 km (40 mi) from shore.

The main commercial fishing gears used along the Atlantic east coast are pots/traps, dredges, trawls, longlines (bottom and pelagic), gillnets, purse seines, and pound nets (Chuenpagdee et al., 2003; Stevenson et al., 2004).

Recreational fishing can be classified as nearshore or offshore, depending on the size of vessel and its fishing location (distance from shore). Nearshore recreational fishing (<4.8 km [3.0 mi]) consists of anglers fishing from private vessels, beaches, marshes, or manmade structures (e.g., jetties, docks, and piers), whereas offshore fishing consists of anglers fishing from larger vessels (private, rental, charter, or party) in offshore waters (>4.8 km [3.0 mi]).

Historical and ongoing effects on listed species from commercial and recreational fishing include vessel strikes; disturbance by vessel traffic and noise; entanglement in lost or discarded fishing gear; incidental taking of demersal fish species as bycatch; effects on prey species due to direct taking of fish and shellfish resources including targeted species and bycatch; and oil spills due to vessel collisions or other accidents.

4.1.3. Military Range Complexes and Civilian Space Program Use

Military range complexes and civilian space program use areas, including restricted areas and danger zones, are established in areas off U.S. coastlines to allow military forces to conduct training and testing activities. Most of the BA Area is within military range complexes and civilian space program use areas, as shown in **Figure A-19**. Military activities can include various air-to-air, air-to-surface, and surface-to-surface naval fleet training, submarine and antisubmarine training, and Air Force exercises.

The five military-related restricted areas operated by the DOD within the BA Area extend from Chesapeake Bay to Jacksonville, Florida (**Figure A-19**). The Atlantic Fleet training Virginia Capes (VACAPES) Range Complex extends along the coastlines of Delaware, Maryland, and North Carolina (U.S. Fleet Forces, 2009). Within the VACAPES Range Complex, the National Aeronautics and Space Administration (NASA), Goddard Space Flight Center's Wallops Flight Facility (WFF) owns and operates a launch range on Virginia's eastern shore. The WFF serves as a flight test site for aerodynamic research, and NASA conducts science, technology, and educational flight projects from WFF aboard rockets, balloons, and unmanned aerial vehicles, using the Atlantic waters for operations on almost a daily basis. The WFF is also home to several critical DOD programs. The Cherry Point Complex extends along the coastline of central North Carolina, and the Charleston Complex extends along the coastline of southern North Carolina and South Carolina. The Jacksonville Complex extends along the coastlines of Georgia and north Florida to the Merritt Island NWR. The fifth military area is the Cape Canaveral Operating Area (OPAREA), which is located along the coastline of Merritt Island (**Figure A-19**). Training exercises include mine, surface, amphibious, and strike warfare involving bombing and missile exercises and mine neutralization. Airborne, surface, and submarine activities are involved. Within the VACAPES Range Complex, five mission impact areas are present that are the debris cones for rocket tests and detonations performed between 2005 and 2007 (**Figure A-19**). These areas were showered with debris ranging in size from golf balls to the size of a small automobile.

Military range complexes and civilian space program use areas are designated for Joint Base Charleston, a combined Air Force and Navy installation in South Carolina, and Parris Island, a marine training facility also in South Carolina. A Danger Zone is also designated offshore Camp Lejeune, North Carolina.

Three military facilities are located at the Port of Jacksonville: the Naval Submarine Base Kings Bay, Naval Air Station Jacksonville, and Naval Station Mayport; together, these facilities represent the third largest concentration of the U.S. Naval fleet in the U.S. (World Port Source, 2011). These facilities also make use of offshore military range complexes and civilian space program use areas.

Military and civilian uses of the offshore sea and air areas are compatible, with Navy ships accounting for 3 percent of the total ship presence out to 371 km (200 nmi) (U.S. Fleet Forces, 2009). Where naval vessels and aircraft conduct operations that are not compatible with commercial or recreational transportation, they are confined to OPAREAs away from commercially used waterways and inside Special Use Airspace (U.S. Fleet Forces, 2009). Hazardous operations are communicated to all vessels and operators by use of Notices to Mariners issued by the USCG and Notices to Airmen issued by the Federal Aviation Administration (FAA).

The NASA also has designated danger zones and restricted areas for rocket testing and shuttle launches. Within the BA Area, NASA restricted areas include Wallops Island in Virginia and offshore of the Kennedy Space Center at Cape Canaveral. The limits of the areas are established offshore of the facilities, and access is restricted during rocket and shuttle launch activities (33 CFR 334.525).

Historical and ongoing effects on listed species from military use include vessel strikes; disturbance by underwater noise from sonars, explosives, and other active acoustic sound sources; disturbance by vessel traffic and noise; disturbance by aircraft traffic and noise; accidental releases of trash and marine debris; and oil spills due to vessel collisions or other accidents.

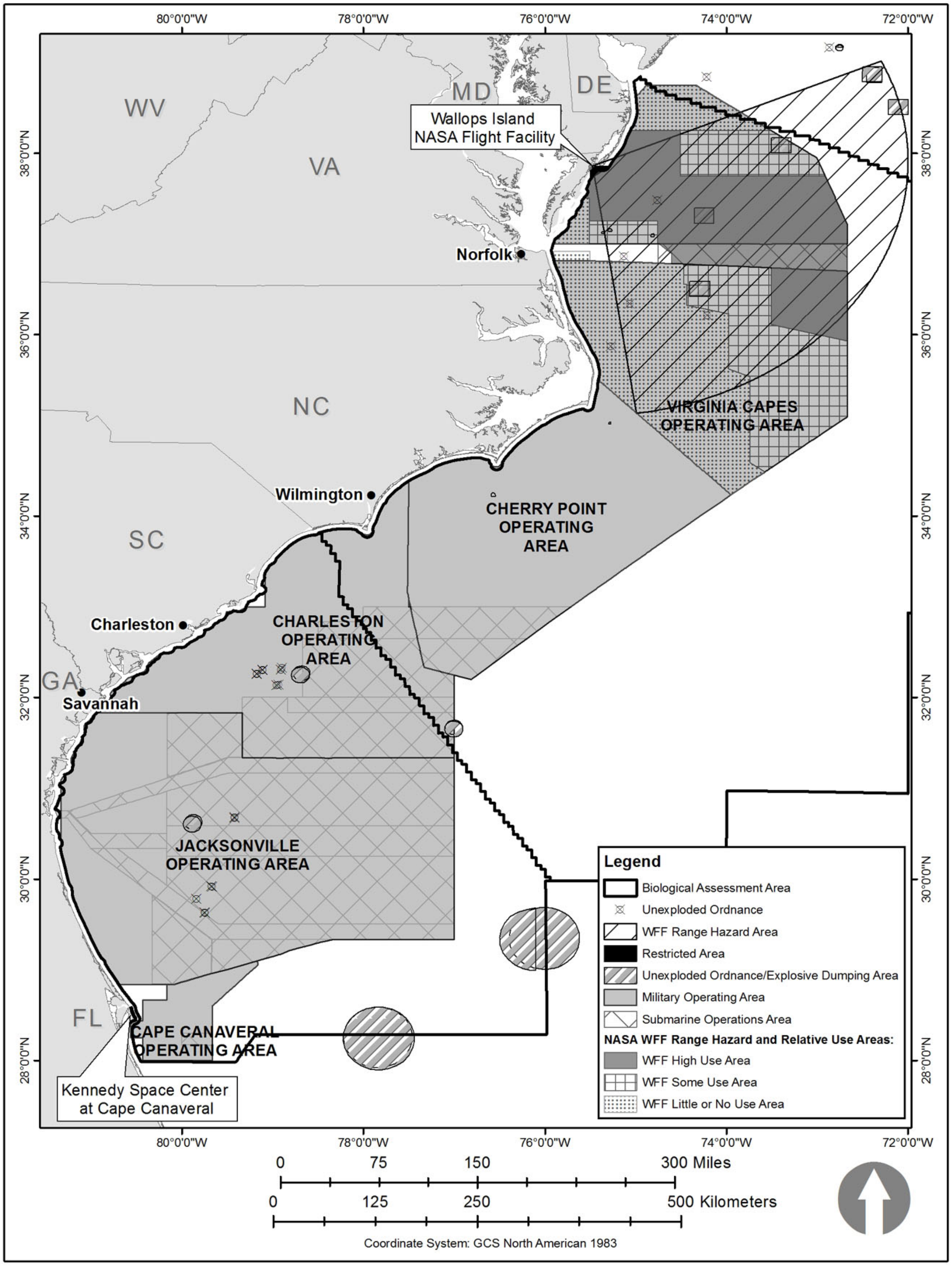


Figure A-19. Military Use, National Aeronautics and Space Administration (NASA)-Restricted, and Ordnance Disposal Areas along the Atlantic Coast. Source: Naval Facilities Engineering Command; 33 CFR 334.595; 33 CFR 334.130.

4.1.4. Sand and Gravel Mining and Beach Restoration

The BOEM may offer and enter into a noncompetitive, negotiated lease for sand, shell, or gravel resources following 1994 amendments to the Outer Continental Shelf Lands Act (OCSLA) (P.L. 103-426) for certain types of projects funded in whole or part by, or authorized by, the Federal Government. The Shore Protection Provisions of the Water Resource Development Act of 1999 amended P.L. 103-426 and prohibited charging State and local governments a fee for using OCS sand. For all other uses, a competitive bidding process is required under Section 8(k)(1) of the OCSLA. The Marine Minerals Program administered by BOEM is dominated by the identification and use of OCS sand for beach nourishment and coastal restoration projects (USDOI, BOEM, 2011c). **Figure A-3** shows the past and recent locations of OCS sand and gravel borrow areas within the BA Area. Locations are as follows:

- Great Gull Bank Borrow Area (offshore Ocean City, Maryland);
- Sandbridge Shoal Borrow Area (offshore Virginia Beach, Virginia);
- Little River Borrow Area (offshore North Myrtle Beach, South Carolina);
- Cane South Borrow Area (offshore Myrtle Beach, South Carolina);
- Surfside Borrow Area (offshore Garden City, South Carolina);
- Jacksonville Borrow Area (offshore Jacksonville, Florida); and
- Canaveral Shoals Borrow Area (offshore Brevard County, Florida).

To date, BOEM has conveyed rights to about 30 million cubic yards of OCS sand for 23 coastal restoration projects in five states. Some of these projects were done on an emergency basis, where imminent breaching of barrier islands was prevented by the rapid placement of OCS sand. Most of these projects used sand that was previously identified by the BOEM through its cooperative sand evaluation program with coastal states (USDOI, BOEM, 2011c).

Historical effects on listed species from marine minerals activities include vessel strikes; disturbance by vessel traffic and noise; incidental taking of sea turtles and demersal fishes (e.g., by hopper dredges); indirect effects due to alteration of benthic habitats and resulting impacts on prey species; accidental releases of trash and marine debris; and oil spills due to vessel collisions or other accidents.

Additional impacts can occur onshore when OCS sand deposits are used for beach restoration. Within the BA Area, beaches are used by sea turtles (mostly loggerheads) for nesting, by piping plovers for foraging (and occasional nesting), and by red knots for foraging. Beach restoration activities can disturb these species and affect the availability and quality of beach habitat. For example, although additional sand may increase the amount of nesting habitat for sea turtles, the quality of the habitat may be less suitable for nesting (Conant et al., 2009).

Future marine minerals activities involving OCS sand resources would require separate ESA consultation and are not part of the environmental baseline.

4.1.5. Renewable Energy Development

There are currently no renewable energy developments within the BA Area. The BOEM has initiated early ESA consultation with for renewable energy activities in the Mid-Atlantic Planning Area offshore Delaware, Maryland, and Virginia (**Figure A-2**). In January 2012, BOEM issued a Final Environmental Assessment for these areas (USDOI, BOEM, 2012a). Potential impacts on listed species from renewable energy site characterization activities include vessel strikes; disturbance by underwater noise from active acoustic sound sources during HRG surveys; disturbance by vessel traffic and noise; disturbance by aircraft traffic and noise; accidental releases of trash and marine debris; and oil spills due to vessel collisions or other accidents.

4.1.6. Oil and Gas Exploration and Development

There are currently no active oil and gas leases or oil and gas exploration, development, or production activities on the Atlantic OCS. Ten oil and gas lease sales were held in the Atlantic between 1976 and 1983. Historically, 51 wells were drilled on the Atlantic OCS between 1975 and 1984, including 1 well in the Mid-Atlantic Planning Area and 7 wells in the South Atlantic Planning Area (USDOI, MMS, 2008b). Due to the limited scale of these historical activities and the time elapsed since they were conducted, these activities are estimated to have no discernable impact on the baseline for listed species in the BA Area. Any future oil and gas exploration and development activities would require separate ESA consultation and are not part of the environmental baseline.

4.1.7. Liquefied Natural Gas Import Terminals

Liquefied natural gas is a form of natural gas that is used mainly for transport to markets, where the liquid is regasified and distributed via pipeline networks. In the U.S., LNG is imported through both offshore and onshore terminals. Licensing of offshore LNG terminals (deepwater ports) is under the jurisdiction of the USCG and the Maritime Administration (MARAD). Onshore LNG terminals are licensed by the Federal Energy Regulatory Commission (FERC). There are two USCG/MARAD licensed deepwater ports offshore the Atlantic coast – Neptune and Northeast Gateway, both located offshore Massachusetts. There are no active, pending applications for deepwater ports on the Atlantic coast (U.S. Department of Homeland Security [USDHS], USCG, 2011a). There are three FERC-licensed LNG terminals in Atlantic states – Everett, Massachusetts; Cove Point, Maryland; and Elba Island, Georgia (FERC, 2012).

Any future LNG port construction would require separate ESA consultation and is not part of the environmental baseline.

Historical impacts on listed species from construction of LNG terminals may have included disturbance by underwater noise from pile driving and other active acoustic sound sources; disturbance by vessel traffic and noise; and accidental releases of trash and marine debris. The main impact-producing factors (IPFs) associated with routine operations of the existing LNG terminals are vessel traffic, along with the associated discharges, air emissions, and noise.

4.1.8. Dredging and Dredged Material Disposal

There are 11 final dredged material disposal sites designated on the Atlantic OCS (40 CFR 228.15). These sites range in size from 3.4-40.5 km^2 (1-11.8 nmi^2) and are used for the disposal of dredged material from the maintenance dredging of commercial and military ports. The locations are offshore of the following areas (**Figure A-20**):

- Dam Neck, Virginia;
- Norfolk, Virginia;
- Morehead City, North Carolina;
- Wilmington, North Carolina;
- Georgetown Harbor, South Carolina;
- Charleston, South Carolina;
- Savannah, Georgia;
- Brunswick Harbor, Georgia;
- Fernandina Beach, Florida;
- Jacksonville, Florida; and
- Canaveral Harbor, Florida.

There are two additional ocean dredged material disposal sites (ODMDSs) located in the BA Area: New Wilmington, North Carolina, and Port Royal, South Carolina. The two areas are 32.2 and 3.4 km^2 (9.4 and 1 nmi^2), respectively (U.S. Environmental Protection Agency [USEPA], 2011).

The disposal sites are used mainly for the disposal of dredged material from the maintenance dredging of commercial ports. Typically, sites are permitted for continuing use, and the activity level varies depending on the dredging requirements for particular ports. Dredging and the disposal of dredged materials are conducted with industry-standard practices to reduce potential effects to the environment, including the suspension of contaminated sediments into the water column. The COE is the permitting authority for dredged material disposal. However, when issuing a permit, the COE must obtain the USEPA's concurrence, use USEPA developed dumping criteria, and use USEPA-designated ocean disposal sites to the maximum extent feasible (33 CFR 324.4(b)).

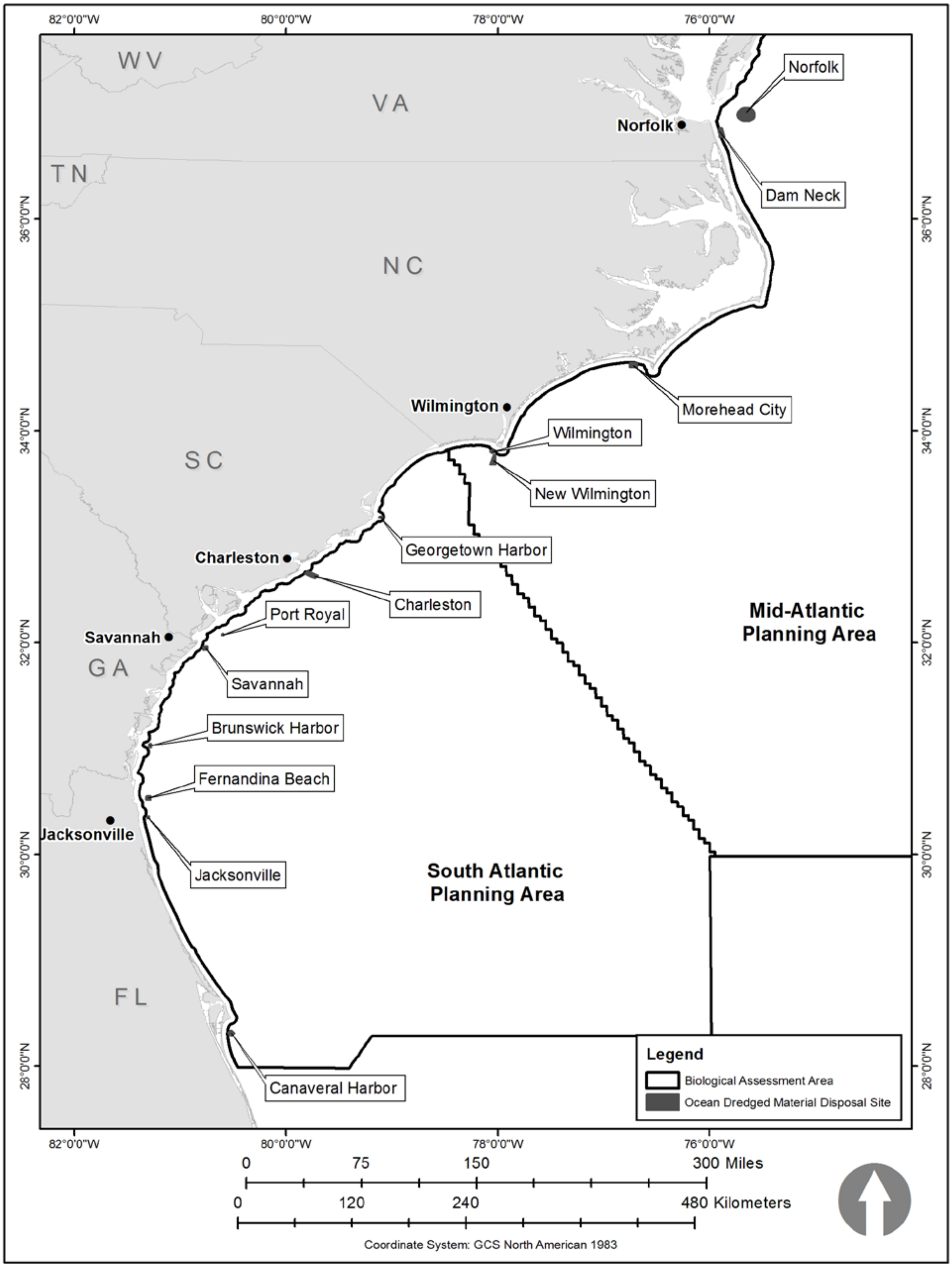


Figure A-20. Ocean Dredged Material Disposal Sites along the Mid-Atlantic and South Atlantic Coasts.

Historical and ongoing effects on listed species from dredged material disposal include vessel strikes; disturbance by vessel traffic and noise; incidental taking of sea turtles and demersal fishes (e.g., by hopper dredges); indirect effects due to alteration of benthic habitats and resulting impacts on prey species; accidental releases of trash and marine debris; and oil spills due to vessel collisions or other accidents.

4.1.9. Coastal Development

Coastal development includes an array of human activities such as beachfront construction of homes, hotels, restaurants, roads, harbors, jetties, seawalls, and other forms of coastal armoring. More than one-half the nation's population now lives and works within 80.5 km (50 mi) of the coastline, but coastal areas account for only 11 percent of the nation's land area. In recent years, 40 percent of new commercial development and 46 percent of new residential development happened near the coast.

Of the listed species in this analysis, sea turtles are the most vulnerable to coastal development, through loss of nesting habitat (USDOC, NMFS and USDOI, FWS, 2008). Beachfront lighting disorients hatchlings when they emerge from the nest, leading them away from the water and towards roads and buildings where they may die of exposure, fall victim to predators or vehicles, or become trapped by obstacles. Beachfront lighting can also disorient nesting females and may result in failed nesting attempts. Obstacles in the coastal zone, from beach chairs to curbs on roads, also impede females and may result in failed nesting attempts. Construction of coastal armoring creates impenetrable barriers to nesting females and causes unnatural erosion of beaches. Beachfront development and measures to control erosion are impenetrable barriers to nesting sea turtles. Increased erosion due to coastal development may force females to nest below the high water line, resulting in nests being washed away.

Atlantic coastal development has also affected habitats used by many birds, including the piping plover, roseate tern, and red knot. Piping plovers in particular are very sensitive to human activities, and disturbances from anthropogenic activities can cause the parent birds to abandon their nests (USDOI, FWS, 1996).

4.2. Mitigation and Conservation Measures Contributing to the Environmental Baseline

Mitigation and conservation measures contributing to the environmental baseline are discussed below. Additional mitigation and monitoring applied to the proposed action can be found in **Section 7** of this BA.

4.2.1. Marine Mammals

Critical habitat has been designated for the North Atlantic right whale and Florida manatee within the BA Area. In 1994, three critical habitats for the North Atlantic right whale were designated by NMFS along the eastern coast of the U.S. (*Federal Register*, 1994). These include Cape Cod Bay/Massachusetts Bay, the Great South Channel, and selected areas off the southeastern U.S. that are within the BA Area (**Figure A-5**). Critical habitat was designated for the Florida manatee on September 24, 1976 (*Federal Register*, 1976) and includes inland waterways in four northeastern Florida coastal counties (Brevard, Duval, St. Johns, and Nassau) that are adjacent to the BA Area (**Figure A-10**).

North Atlantic right whale SMAs include vessel speed restrictions within the Mid-Atlantic and southeast U.S. (**Figure A-21**) under 50 CFR 224.105. The Southeast U.S. SMA has seasonal restrictions in effect from November 15 to April 15 of each year within a continuous area that extends from St. Augustine, Florida, to New Brunswick, Georgia, and offshore 37 km (20 nmi) from shore. The Mid-Atlantic U.S. SMA has seasonal restrictions in effect from November 1 through April 30 and includes a combination of both continuous areas and half circles drawn with 37-km (20-nmi) radii around the entrances to certain bays and ports. Within the BA Area, the Mid-Atlantic U.S. SMA includes a continuous zone extending between Wilmington, North Carolina, and New Brunswick, Georgia, as well as the Ports of Delaware Bay (Wilmington, Philadelphia), the entrance to the Chesapeake Bay (Ports of Hampton Roads and Baltimore), and the Ports of Morehead City and Beaufort, North Carolina.

Science, Service, Stewardship

Migratory Route

November 1 through April 30

Vessel speed is restricted in the following areas:

- Block Island Sound waters bounded by:
  40°51'53.7" N 070°36'44.9" W
  41°20'14.1" N 070°49'44.1" W
  41°04'16.7" N 071°51'21.0" W
  40°35'56.5" N 071°38'25.1" W
  then back to starting point.
- Within a 20-nm (37 km) radius of the following (as measured seaward from the COLREGS lines):
  - Ports of New York/New Jersey:
    40°29'42.2"N 073°55'57.6"W
  - Entrance to the Delaware Bay (Ports of Philadelphia and Wilmington):
    38°52'27.4"N 075°01'32.1"W
  - Entrance to the Chesapeake Bay (Ports of Hampton Roads and Baltimore):
    37°00'36.9"N 075°57'50.5"W
  - Ports of Morehead City and Beaufort, NC:
    34°41'32.0"N 076°40'08.3"W
- Within a continuous area 20 nm from shore between Wilmington, NC, to Brunswick, GA, bounded by the following:

Point	Latitude	Longitude
A	34°10'30"N	077°49'12"W
B	33°56'42"N	077°31'30"W
C	33°36'30"N	077°47'06"W
D	33°28'24"N	078°32'30"W
E	32°59'06"N	078°50'18"W
F	31°50'00"N	080°33'12"W
G	31°27'00"N	080°51'36"W

and west back to the shore.

Calving and Nursery Grounds

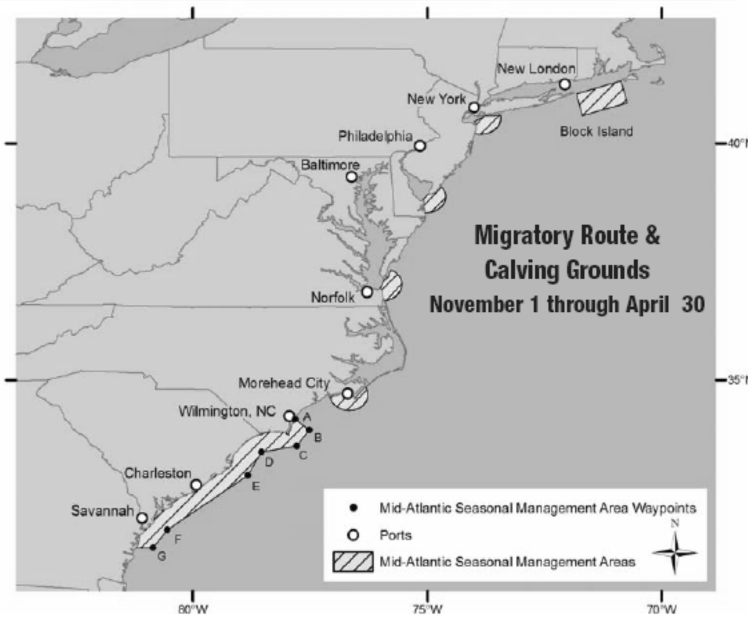
November 15 through April 15

Vessel speed is restricted in the area bounded to the north by latitude 31°27'N; to the south by latitude 29°45'N; to the east by longitude 080°51'36"W.

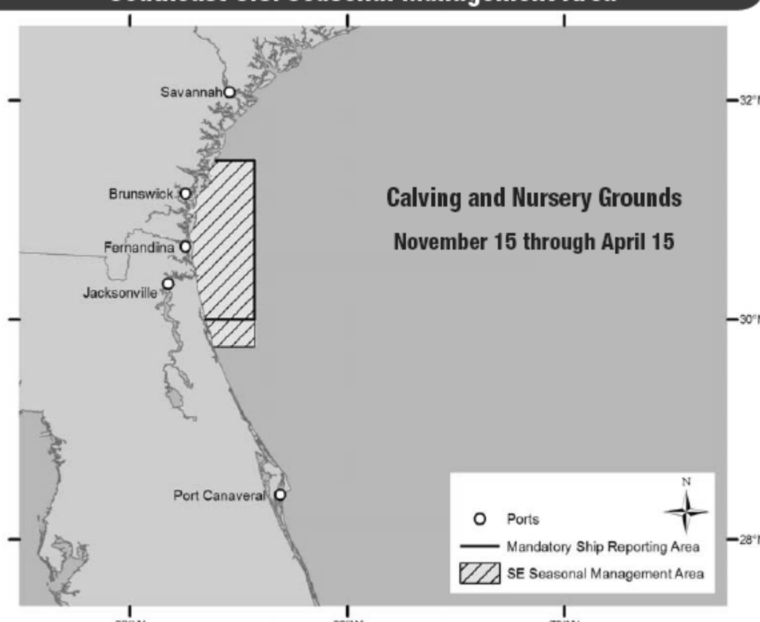
For more information, visit:
http://www.nmfs.noaa.gov/pr/shipstrike
http://nero.noaa.gov/shipstrike
http://rightwhalessouth.nmfs.noaa.gov

Right Whale Ship Strike Reduction Rule expires on December 9, 2013

Mid-Atlantic U.S. Seasonal Management Areas



Southeast U.S. Seasonal Management Area



The rule does not apply to waters inshore of COLREGS lines.

Voluntary Dynamic Management Areas (DMAs) may also be established by NOAA Fisheries Service. Mariners are encouraged to avoid these areas or reduce speeds to 10 knots or less while transiting through these areas. NOAA Fisheries Service will announce DMAs to mariners through its customary maritime communication media.

Figure A-21. Summary of Speed Restrictions and Locations for Vessel Operators to Comply with the Right Whale Strike Reduction Rule (50 CFR 224.105). Source: USDOC, NOAA (2011).

Manatee Protection Zones were developed in inshore waterways of Florida adjacent to the BA Area to reduce risks to manatees and their habitat by limiting boat speeds or boat/human access in specific geographic areas (50 CFR 17.108). Manatee protection zones are now established in five Florida counties adjacent to the BA Area (Duval, St. Johns, Flagler, Volusia, and Brevard) (Florida Fish and Wildlife Conservation Commission, 2007). The protection zones are managed by the State of Florida Fish and Wildlife Conservation Commission. Areas within St. Johns and Brevard Counties are also managed by the FWS.

The U.S. Navy has authorization to conduct sonar training under the Atlantic Fleet Sonar Training EIS and associated permits. As part of their authorized action, they have implemented the following mitigation measures to decrease potential effects on marine mammals (U.S. Department of the Navy, 2008):

- avoid important habitats and marine protected areas;
- maneuver to stay at least 457 m (1,500 ft) away from observed whales;
- implement protective measures for North Atlantic right whales;
- post shipboard lookouts;
- monitor visually and acoustically for marine mammals and sea turtles prior to and during training; and
- reduce source level or shut down sonar if marine mammals are detected within specified exclusion zones (914 m [3,000 ft] for reduced power; 183 m [600 ft] for shutdown).

The NMFS implemented the Atlantic Large Whale Take Reduction Plan (ALWTRP) in 1997 to reduce the level of serious injury and mortality of three strategic stocks of large whales (North Atlantic right whales, humpback whales, and fin whales) in commercial gillnet and trap/pot fisheries. The measures identified in the ALWTRP are also designed to benefit minke whales, which are not designated as a strategic stock but are known to be incidentally injured or killed in gillnet and trap/pot fisheries. The ALWTRP has several components, including restrictions on where and how gear can be set; research into whale populations and whale behavior, as well as fishing gear interactions and modifications; outreach to inform and collaborate with fishermen and other stakeholders; and a large whale disentanglement program.

4.2.2. Sea Turtles

Since one of the greatest sources of mortality for certain sea turtle species results from interaction with commercial fishing vessels and gear (Wallace et al., 2010), NMFS, conservation groups, and the commercial fishing industry have been working to develop methods and gear that reduce the incidental capture or harm to sea turtles. Effective measures to reduce turtle bycatch include the use of circle hooks and fish bait in longline fisheries, and TEDs in trawling. A TED is an angled grid of bars with a hinged opening that is fitted into the neck of a shrimp trawl net. The TED is designed to allow small animals such as shrimp to pass through the bars into the bag end of the net and allow larger animals, such as marine turtles and sharks, to pass through the hinged door after striking the angled grid bars. Federal fisheries regulations regarding the use of TEDs include

- 50 CFR 223.205: Sea Turtles;
- 50 CFR 223.206: Exemptions to TED Requirements; and
- 50 CFR 223.207: Currently Approved TED Designs.

Direct injury or mortality of sea turtles by hopper dredges has been well documented along the southeastern and Mid-Atlantic coast (National Research Council [NRC], 1990). Solutions, including modification of dredges and time/area closures, have been successfully implemented to reduce mortalities and injuries in the U.S. (Conant et al., 2009).

Other conservation measures have targeted conservation and preservation of nesting beaches, and thousands of volunteers around the globe participate in nest protection and other activities on beaches during the nesting season. These efforts are intended to increase survival of eggs and hatchlings in an attempt to increase the success of getting hatchlings into the ocean, to offset other mortality factors faced by sea turtles.

The Archie Carr NWR, located at the southern boundary of the BA Area, was established in 1991 to help protect the most important nesting area for loggerhead turtles in the western hemisphere and the most important green turtle nesting beach in North America (USDOI, FWS, 2011e). It has been estimated that 25 percent of all loggerhead nesting in the U.S. occurs in the Archie Carr NWR. The 100-ha (248-ac) refuge is critical to the recovery and survival of loggerhead turtles.

4.2.3. Birds

In 2001, the FWS designated critical habitat for the wintering population of piping plovers along the coasts of North Carolina, South Carolina, Georgia, and Florida (50 CFR 17). Critical habitat areas were subsequently revised in North Carolina in 2008 (*Federal Register*, 2008). Coastline habitat essential for the conservation of this listed species includes intertidal beaches, flats, and/or associated dunes extending down to the lowest low-tide mark. This designation is designed to reduce potential impacts from coastal development, beach nourishment, and onshore recreational activities.

National wildlife refuges, national seashores, and other managed areas along the coast of the BA Area help to maintain and protect habitat for marine and coastal birds including piping plovers, roseate terns, and red knots. As listed in **Chapter 4.2.11** of the Draft Programmatic EIS, these include seven NWRs (Chincoteague, Fisherman Island, Back Bay, Currituck, Pea Island, Blackbeard Island, and Merritt Island), five national seashores (Assateague Island, Cape Hatteras, Cape Lookout, Cumberland Island, and Canaveral), and numerous state parks, resource conservation areas, nature preserves, aquatic preserves, natural areas, and wildlife management areas.

In 2001, the NMFS established the Dr. Carl N. Shuster, Jr. Horseshoe Crab Sanctuary in Federal waters off the mouth of the Delaware Bay estuary. The sanctuary was created to protect the large spawning population of horseshoe crabs in Delaware Bay and maintain the abundance of crab eggs available to migratory shorebirds, including the red knot. The reduction in horseshoe crab eggs due to harvesting of horseshoe crabs has been identified as a key threat to the survival of this species (USDOI, FWS, 2010a,b).

4.2.4. Fishes

The NMFS developed a recovery plan for the smalltooth sawfish in January 2009 (USDOC, NMFS, 2009a). The plan recommends specific steps to recover the DPS, focusing on reducing fishing impacts, protecting important habitats, and educating the public. Smalltooth sawfish are extremely vulnerable to overexploitation because of their propensity for entanglement in nets (USDOC, NMFS, 2011e). The NMFS has developed guidelines telling fishermen how to safely handle and release any sawfish they catch. In addition, the NMFS has developed guidelines to reduce impacts on smalltooth sawfish during coastal dredging and construction projects (USDOC, NMFS, 2006). Some states have taken additional steps to protect this species; Florida, Louisiana, and Texas have prohibited the “take” of sawfish. Florida's existing ban on the use of gill nets in state waters is an important conservation tool. Three NWRs in Florida also protect their habitat (USDOC, NMFS, 2011e).

A recovery plan for shortnose sturgeon was developed by the NMFS in 1998 (USDOC, NMFS, 1998b). Shortnose sturgeon may be caught incidental to shad fishing during spring spawning migrations. To increase access to spring spawning habitat, fish ladders around dams and other river obstructions have been constructed, improving reproductive potential.

The Atlantic sturgeon is managed under a Fishery Management Plan implemented by the Atlantic States Marine Fisheries Commission (ASMFC). In 1998, the ASFMC instituted a coast-wide moratorium on the harvest of Atlantic sturgeon, which is to remain in effect until there are at least 20 protected age classes in each spawning stock (anticipated to take up to 40 or more years) (USDOC, NMFS, 2012a). The NMFS followed the ASMFC moratorium with a similar moratorium for Federal waters. Amendment 1 to ASMFC's Atlantic sturgeon Fishery Management Plan also includes measures for preservation of existing habitat, habitat restoration and improvement, monitoring of bycatch and stock recovery, and breeding/stocking protocols (USDOC, NMFS, 2012a).

Because of their candidate status, the NMFS has not yet developed recovery plans for alewife or blueback herring. In response to the declining trend for river herring, the states of Massachusetts, Rhode Island, Connecticut, and North Carolina have instituted moratoriums on taking and possessing river herring. The North Carolina Division of Marine Fisheries has developed a River Herring Fisheries

Management Plan that details the steps necessary to recover North Carolina's river herring populations (USDOC, NMFS, 2009b).

5. EFFECTS OF THE ACTION

Section 7(a)(2) of the ESA requires each Federal agency, in consultation with and with the assistance of NMFS and FWS as appropriate, to insure that any action authorized, funded, or carried out is not likely to reduce appreciably the likelihood of a species' survival and recovery in the wild by reducing its reproduction, numbers, or distribution. Section 7(a)(2) also requires Federal agencies to insure that any action authorized, funded, or carried out is not likely to destroy or adversely modify critical habitat.

Under the ESA, Federal agencies must evaluate the effects of the action on listed species, including whether and what types of "take" is anticipated to occur. Take is defined under the ESA as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." "Harass" is defined as "…an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly impair normal behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3) and "harm" as "… significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering" (50 CFR 17.3).

Negative effects from G&G activities on listed species or critical habitat may occur either from routine activities or from accidental events. These impacts may be direct or indirect. The impact determination considers context (the geographic, biophysical, and social context in which the effects will occur), intensity (the severity of the impact, in whatever context[s] it occurs), and duration (short- versus long-term) of potential impacts. The section to follow analyzes the potential range of effects from the Proposed Action on ESA-listed species and ESA-designated critical habitat.

5.1. SCENARIO SUMMARY AND IMPACT-PRODUCING FACTORS

5.1.1. Relevant Impact-Producing Factors

Table A-11 summarizes scenario elements for the three program areas (oil and gas exploration, renewable energy, and marine minerals). Based on the scenario, the following IPFs have been identified as relevant to the listed species in this analysis:

- Active acoustic sound sources;
- Vessel and equipment noise;
- Vessel traffic;
- Aircraft traffic and noise;
- Trash and debris;
- Seafloor disturbance;
- Drilling discharges; and
- Accidental fuel spills.

Table A-12 summarizes the IPFs with respect to the associated survey types and program areas included in the proposed action. **Table A-13** indicates the applicable IPFs for each group in this analysis (marine mammals, sea turtles, birds, and fishes).

The IPFs applicable to listed marine mammals are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Impacts of drilling discharges are considered negligible for marine mammals due to the rapid dispersion of the effluents. Seafloor disturbance is not an IPF for the listed whales because none of them use benthic habitats to any significant degree. The benthic habitats used by the Florida manatee are in inland waters, which are outside the BA Area.

The IPFs applicable to listed sea turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Impacts of seafloor disturbance are considered negligible for sea turtles because of the relatively small area of seafloor affected, and impacts of drilling discharges are considered negligible because of the rapid dispersion of the effluents.

The IPFs applicable to listed birds are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Impacts of drilling discharges are considered negligible for birds due to the rapid dispersion of the effluents. Seafloor disturbance is not an IPF for birds because they do not use offshore benthic habitats.

The IPFs applicable to listed fish species are active acoustic sound sources, trash and debris, seafloor disturbance, drilling discharges, and accidental fuel spills.

Table A-11

Scenario Elements for Proposed G&G Activities in the Mid- and South Atlantic Planning Areas, 2012-2020

Activity Type	Purpose	Number of Events or Level of Effort	Primary Platform and Size	Scale of Activity	Penetration Depth	Approximate Duration/ Event	Shore Base[a]	Service Vessel	High-Energy Sound Source(s)	Bottom Area Disturbed
Oil and Gas Exploration										
2D Seismic Survey	Identify geologic structure	1-10	1 ship, ~100 m	617,775 line km	kms to 10s of kms	2-12 months	0 to 1	0 to 1	Airgun array	None
3D Seismic Survey	Identify geologic structure	5-10	1-2 ships, ~100 m	2,500 OCS blocks	kms to 10s of kms	4-12 months	0 to 1	0 to 1	Dual airgun array	None
3D WAZ and 3D FAZ Coil	Better define complex geologic structure	1-2	4 ships, ~100 m	900 line km	kms to 10s of kms	1 year	0 to 2	1 to 2	4 x arrays	None
Vertical Seismic Profiling	Calibrate seismic with known geology	3-8	1 ship, ~30 m	1,280 line km	100s to 1,000s of m	3-4 days	1	None	Single airgun	
High-Resolution Seismic Survey	Shallow hazards assessment and archaeological determinations	10-20	1 ship, ~30 m	175,465 line km	10s to 100s of m	3 days – 1 week	1	None	• 1-2 airguns • Boomer or chirp subbottom profiler • Side-scan sonar • Multi-beam depth sounder	None
3D Controlled Source Electromagnetic	Optimize reservoir production	0-2	1 ship, ~20-100 m	119,760 km	3-5 km	1-6 months	0 to 1	0 to 1	None	Anchors with bottom receivers, <1 OCS block
Magnetotelluric Survey	Optimize reservoir production	0-2	1 ship, ~20-100 m	100s to 1,000s of line kms; or ≤9 OCS blocks	3-5 km	1-6 months	0 to 1	0 to 1	None	Anchors with bottom receivers, <1 OCS block
Gravity and Magnetic	Passive measurement, gravity and magnetic fields	0-5	Acquisition with seismic typical	100s to 1,000s of line kms	kms to 10s of kms	4-12 months	0 to 1	0 to 1	None	None
Aeromagnetic	Passive measurement, magnetic fields	1-2	1 aircraft	100s to 1,000s of line kms	kms to 10s of kms	1-3 months	0 to 1	0	None	None
COST Well	Test drilling outside of lease program	0-3 well	Platform or drillship, ~100 m	<1/16 OCS block	≥150 m	5-30 days	0 to 1	0 to 2	None	≤2 ha per well
Shallow Test Drilling	Test drilling outside of lease program	0-5 wells	Platform or drillship, ~100 m	<1/16 OCS block	<150 m	5-30 days	0 to 1	0 to 2	None	≤2 ha per well
Bottom Sampling	Extract sediment core	50-300	1 barge or ship, ~20 m	<1/16 OCS block	<300 m	<3 days	0 to 1	None	None	~10 m^2, per sample

Table A-11. Scenario Elements for Proposed G&G Activities in the Mid- and South Atlantic Planning Areas, 2012-2020 (continued).

Activity Type	Purpose	Number of Events or Level of Effort	Primary Platform and Size	Scale of Activity	Penetration Depth	Approximate Duration/ Event	Shore Base[a]	Service Vessel	High-Energy Sound Source(s)	Bottom Area Disturbed
Renewable Energy										
High-Resolution Geophysical Survey	Shallow hazards assessment and archaeological determinations	1 or more surveys per state	1 ship, ~20-30 m	Each survey ≥1/16 OCS block[b] plus cable route to shore; Total 211,585 line km (about 220 OCS blocks)	Surficial to 10s to 100s of meters	3 days – 1 weeks	1	None	• Boomer or chirp subbottom profiler • Side-scan sonar • Multi-beam depth sounder	None
Cone Penetrometer Test	Measure sediment engineering properties	2,712-8,374	1 barge or ship, ~20 m	≥1/16 OCS block or along cable route to shore	<10 m	<3 days	1	None	None	~10 m^2 per sample
Geologic Coring	Extract sediment core	2,712-8,374	1 barge or ship, ~20 m	≥1/16 OCS block or along cable route to shore	<300 m	<3 days	1	None	None	~10 m^2 per sample
Grab Sampling	Collect sediment and benthic fauna	2,712-8,374	1 barge or ship, ~20 m	≥1/16 OCS lock or along cable route to shore	<1 m	<3 days	1	None	None	~10 m^2 per sample
Bottom-Founded Monitoring Buoy	Measure ocean and meteorological conditions	7-38	1 barge or ship, ~20 m	≥1/16 OCS block	Surficial	<3 days	1	None	None	~1 m^2 per buoy
2D or 3D Deep Penetration Seismic	Evaluate formation for carbon sequestration	0 to 1 survey	1 ship, ~100 m	<1 OCS block	km to 10s of km	1 - 30 days	1	0-2	Airgun array or dual array	None
Marine Minerals										
High-Resolution Geophysical Survey	Shallow hazards assessment and archaeological determinations	10-40 surveys, 9-21 wks	1 ship, ~30 m	~1,904-12,090 line kms; or 1-4.5 OCS blocks	10s to 100s of m	3 days - 1 weeks	1	None	• Boomer or chirp subbottom profiler • Side-scan sonar • Multi-beam depth sounder	None
Vibracoring	Extract sediment core	6-24 events (90-600 cores)	1 barge or ship, ~20 m	≥1/16 OCS block	10-15 m	3-5 days	1	None	None	~10 m^2 per sample
Geologic Coring	Extract sediment core	1-4 events (1-8 cores)	1 barge or ship, ~20 m	≥1/16 OCS block	<300 m	<3 days	1	None	None	~10 m^2 per sample
Grab Sampling	Collect sediment and benthic fauna	2-8 events (60-320 grabs)	1 barge or ship, ~20 m	≥1/16 OCS block	<1 m	<3 days	1	None	None	~10 m^2 per sample

Abbreviations: COST = Continental Offshore Stratigraphic Test; FAZ = Full Azimith Survey; N/A = Not applicable; OCS = Outer Continental Shelf; WAZ = Wide Azimith Survey.

[a] Shore base is the point of deployment to return berth.

[b] 1/16 of an OCS block (256 ac) is the smallest area considered for renewable energy leasing. All full-build out renewable energy projects in the Mid- and South Atlantic Planning Areas are wind park facilities that would be considerably larger than 1/16 of an OCS block. The average OCS wind park would be ≤10 OCS blocks in size.

Table A-12

Impact-Producing Factors Relevant to the ESA-Listed Species in this Analysis

Impact-Producing Factor	Program Area			Survey Type(s)	Brief Description
	OG	RE	MM		
Active Acoustic Sound Sources					
Airguns	X	--	--	Deep penetration seismic surveys and HRG surveys	Underwater noise from compressed air release
Electromechanical Sources	X	X	X	HRG surveys of renewable energy and marine mineral sites but also oil/gas	Underwater noise from subbottom profilers, side-scan sonar, and multi-beam depth sounders
Vessel and Equipment Noise	X	X	X	All vessel surveys; drilling of COST wells and shallow test wells	Underwater noise from vessel engines and equipment, and from drilling activities
Vessel Traffic	X	X	X	All vessel surveys	Vessel movements including survey lines and round trips to onshore base
Aircraft Traffic and Noise	X	--	--	Aeromagnetic surveys; helicopter support for COST well drilling	Aircraft traffic, and noise from engines and propellers
Trash and Debris	X	X	X	All vessel surveys	Accidental release of trash or debris into the ocean
Seafloor Disturbance					
Bottom Sampling	X	X	X	Geotechnical sampling and testing	Collection of vibracore, geologic core, and grab samples; CPT testing
Cables, Nodes, Anchors	X	--	--	Certain deep penetration seismic surveys and CSEM and MT surveys	Temporary placement of cables, nodes, sensors, or anchors on or in seafloor
COST Wells and Shallow Test Drilling	X	--	--	Drilling of COST wells and shallow test wells	Seafloor disturbance due to placement of well template, jetting of well, and anchoring of drilling rig
Meteorological Buoys	--	X	--	Site characterization for renewable energy areas	Temporary anchoring of meteorological buoys
Drilling Discharges	X	--	--	Drilling of COST wells and shallow test wells	Release of drilling fluids and cuttings at seafloor and from drilling rig
Accidental Fuel Spills	X	X	X	All vessel surveys	Potential for release of diesel or fuel oil from a vessel accident

Abbreviations: CSEM = controlled source electromagnetic; COST = Continental Offshore Stratigraphic Test; CPT = cone penetrometer test; HRG = high resolution geophysical; MM = marine minerals; MT = magnetotelluric; OG = oil and gas exploration; RE = renewable energy.

Table A-13

Preliminary Screening of Potential Impacts on Listed Species and Their Critical Habitats

Group and Listed Species	Impact-Producing Factor							
	Active Acoustic Sound Sources	Vessel and Equipment Noise	Vessel Traffic	Aircraft Traffic and Noise	Trash and Debris	Seafloor Disturbance	Drilling Discharges	Accidental Fuel Spills
Marine Mammals North Atlantic right whale Blue whale Fin whale Sei whale Humpback whale Sperm whale Florida manatee	X	X	X	X	X	--	--	X
Sea Turtles Loggerhead turtle Green turtle Hawksbill turtle Kemp's ridley turtle Leatherback turtle	X	X	X	X	X	--	--	X
Marine and Coastal Birds Roseate tern Bermuda petrel Piping plover Red knot	X	X	X	X	X	--	--	X
Fishes Smalltooth sawfish Shortnose sturgeon Atlantic sturgeon Alewife Blueback herring	X	--	--	--	X	X	X	X

X = potential impact. -- = no impact expected.

5.1.2. Impact-Producing Factors Not Considered Further

The Programmatic EIS identified several other IPFs, including onshore support activities and vessel waste. Onshore support activities refers to activities within onshore bases, such as employment and purchase of supplies and services; these are not relevant to any of the listed species, as the associated vessel and aircraft traffic are considered separately as IPFs. Vessel wastes are discussed below but were screened out in the initial analysis because no significant impacts on listed species are expected.

Operational waste generated from all vessels associated with the proposed action includes bilge and ballast waters, trash and debris, and sanitary and domestic wastes. Discharges are regulated by the USCG under 33 CFR 151. Bilge water is water that collects in the lower part of a ship. The bilge water may be contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures of greater than 15 parts per million (ppm) into the territorial sea is prohibited under 33 CFR 151.10. However, discharge is not prohibited in waters farther than 22 km (12 nmi) from shore if the oil concentration is less than 100 ppm. As a result, to the extent that bilge water is expelled at sea, BOEM anticipates that the discharge would be more likely to occur beyond 22 km (12 nmi) from shore.

Ballast water is used to maintain the stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil. However, the same discharge criteria apply to ballast water as to bilge water (33 CFR 151.10). The USCG has proposed a Ballast Water Discharge Standard, which is currently in review (USDHS, USCG, 2011c).

All vessels with toilet facilities must have a Type II or Type III marine sanitation device (MSD) that complies with 40 CFR 140. A Type II MSD macerates waste solids so that the discharge contains no suspended particles and has a bacteria count below 200 per 100 milliliters (ml). Type III MSDs are holding tanks and are the most common type of MSD found on boats. These systems are designed to retain or treat the waste until it can be disposed of at the proper shoreside facilities. State and local governments regulate domestic or gray water discharges. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship, including gray water that is generated from dishwasher, shower, laundry, bath, and washbasin drains. Gray water from vessels is not regulated outside the State's territory and may be disposed of overboard. Gray water should not be processed through the MSD, which is specifically designed to handle sewage. The BOEM assumes that vessel operators would discharge gray water overboard outside of State waters or store it aboard ship until they are able to dispose of it at a shoreside facility.

Based on compliance with the USCG and USEPA regulations, effluent discharges from G&G survey vessels are expected to be diluted and dispersed rapidly in the open ocean. They are not expected to have any detectable effects on the listed marine mammal, sea turtle, bird, or fish species in this analysis.

5.2. Active Acoustic Sound Sources

Two general types of active acoustic sound sources are included in the proposed action: airguns and electromechanical sources (e.g., boomer and chirp subbottom profilers, side-scan sonars, and multibeam depth sounders). **Table A-14** summarizes characteristics of these sources. Detailed characteristics and assumptions are discussed in **Appendix D** of the Programmatic EIS.

Airguns

Airguns would be used as seismic sources during deep penetration seismic surveys for oil and gas exploration, and likely for any post-lease HRG surveys of oil and gas leases. The BOEM does not anticipate that airguns will be used for marine minerals sites. HRG surveys for renewable energy site assessment activities are also not expected to use air guns. However, there may be limited instances where a single air gun is required (i.e., in areas where deeper penetration into the seabed is needed for turbine placement). If requested, BOEM would consider their use within its project specific NEPA analysis and will also consult with NMFS and/or FWS.

In addition, the renewable energy scenario includes the possibility that a deep penetration (2D or 3D) seismic survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic airgun survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

An airgun is a stainless steel cylinder charged with high-pressure air. The acoustic signal is generated when the air is released nearly instantaneously into the surrounding water column. Seismic pulses are typically emitted at intervals of 5-60 s, and occasionally at shorter or longer intervals.

Although airguns have a frequency range from about 10-2,000 Hz, most of the acoustic energy is radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions, but airgun arrays do possess some directionality due to different phase delays between guns in different directions.

Individual airguns are available with a wide range of chamber volumes, from under 5 $in.^3$ to over 2,000 $in.^3$, depending on the survey requirements. Airgun sources can range from a single airgun (for HRG surveys) to a large array of airguns (for deep penetration seismic surveys). The volume of airgun arrays used for seismic surveys can vary from about 45-8,000 $in.^3$. For the analysis in the Programmatic EIS, two sizes of airgun arrays were modeled, based on current usage in the Gulf of Mexico, and considered representative for potential Atlantic G&G seismic surveys:

- large airgun array (5,400 $in.^3$). This array was used to represent sound sources for deep penetration seismic surveys, including 2D, 3D, WAZ, and other variations.
- small airgun array (90 $in.^3$). This array was used to represent sound sources for HRG surveys for oil and gas exploration sites.

The large airgun array has dimensions of 16 by 15 m (52.5 by 49.2 ft) and consists of 18 airguns placed in three identical strings of six airguns each. The volume of individual airguns ranges from 105-660 $in.^3$. The depth below the sea surface for the array was set at 6.5 m (21.3 ft). The small airgun array consists of two airguns of 45 in.^{3} each, placed with 1 m (3.3 ft) separation from each other at a depth of 6.5 m (21.3 ft).

Broadband source levels are 230.7 dB re 1 µPa for the large airgun array and 210.3 dB re 1 µPa for the small array (**Table A-14**). The two arrays differ in both their total source level and the frequency spectrum; large arrays have more low frequencies due to the presence of large volume airguns.

Table A-14

Characteristics of Representative Active Acoustic Sound Sources Included in the Proposed Action. Shaded entries in the last three columns indicate that no auditory impacts are expected because the frequency is beyond the hearing range of marine mammals, sea turtles, or fishes (birds are not included because their exposure to underwater noise would be very limited).

Source	Usage	Broadband Source Level (dB re 1 µPa at 1 m)	Operating Frequencies	Within Hearing Range		
				Marine Mammals	Sea Turtles	Fishes
Large Airgun Array (5,400 in.^{2})	Deep penetration seismic surveys, oil and gas exploration (2D, 3D, WAZ, VSP, 4D, etc.)	230.7	10-2,000 Hz (most energy at <200 Hz)	Yes	Yes	Yes
Small Airgun Array (90 in.^{2})	HRG surveys, oil and gas exploration	210.3	10-2,000 Hz (most energy at <200 Hz)	Yes	Yes	Yes
Boomer	HRG surveys, all program areas	212	200 Hz–16 kHz	Yes	Yes	Yes
Side-Scan Sonar	HRG surveys, all program areas	226	100 kHz	Yes	No	No[b]
			400 kHz	No	No	No[b]
Chirp Subbottom Profiler	HRG surveys, all program areas	222	3.5 kHz	Yes	No	No[b]
			12 kHz	Yes	No	No[b]
			200 kHz	No	No	No[b]
Multibeam Depth Sounder[a]	HRG surveys, all program areas	213	240 kHz	No	No	No[b]

[a] Single beam depth sounders may also be used for seafloor mapping, and the frequencies and source levels may differ. The multibeam depth sounder was selected as a representative source and is conservative from the standpoint of acoustic impacts.

[b] Smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon are unlikely to hear any of the representative side-scan sonar, chirp subbottom profiler, or multibeam depth sounder frequencies. Alewife and blueback herring may detect some of these frequencies, but their sensitivity is considered poor.

Source: **Appendix D** of the Programmatic EIS.

Sound propagation modeling for acoustic sources included in the proposed action was conducted as described in **Appendix D** of the Programmatic EIS. Based on this modeling, **Table A-15** lists the estimated maximum range of Level A and Level B harassment of cetaceans based on current NMFS criteria. The Level A criterion is defined by a received sound pressure level (SPL) of 180 dB re 1 µPa, and the Level B criterion is defined by a received sound pressure level of 160 dB re 1 µPa. As shown in **Table A-15**, the Level A harassment zone could extend up to 2.1 km (1.3 mi) from a large airgun array (5,400 in.^{3}) and up to 186 m (610 ft) from a small airgun array (90 in.^{3}), depending on the geographic location and season modeled. The Level B harassment zone could extend up to 15 km (9.3 mi) from a large airgun array (5,400 in.^{3}) and up to 3 km (1.9 mi) from a small airgun array (90 in.^{3}), depending on the geographic location and season modeled.

Table A-15

Summary of Radial Distances to the 160- and 180-dB (rms) Isopleths from a Single Pulse for Various Equipment

Equipment	Number of Scenarios Modeled	Pulse Duration	Adjustment (dB) for Short Pulse Duration[a]	180-dB Radius (m)		160-dB Radius (m)	
				Calculated using Nominal Source Level[b]	Recalculated for Short Pulse Duration[a]	Calculated using Nominal Source Level[b]	Recalculated for Short Pulse Duration[a]
Large Airgun Array (5,400 in.^{3}), 2D and 3D Surveys	35	>100 ms	--	799-2,109 (mean=1,086)	--	5,184-15,305	--
Small Airgun Array (90 in.^{3}), Oil and Gas HRG Surveys	35	>100 ms	--	76-186 (mean=128)	--	1,294-3,056	--
Boomer	14	180 µs	-27.3	38-45	<5	1,054-2,138	16
Side-Scan Sonar	14	20 ms	-7.0	128-192	65-96	500-655	337-450
Chirp Subbottom Profiler	14	64 ms	-1.9	32-42	26-35	359-971	240-689
Multibeam Depth Sounder	7	225 µs	-26.5	27	<5	147-156	12

[a] For sources with a pulse duration <100 ms, the nominal source level was adjusted by the amount indicated to produce a second, "recalculated" radius for both the 180-dB and 160-dB criteria. See **Appendix D** of the Programmatic EIS.
[b] The value is the radius (Rmax) for the maximum received sound pressure level. See **Appendix D** of the Programmatic EIS.
Source: **Appendix D** of the Programmatic EIS.

Electromechanical Sources

Electromechanical sources are used in HRG surveys for renewable energy development and sand source evaluation but may also be used for oil/gas purposes. In these surveys, a high-resolution boomer or chirp subbottom profiler is typically used to delineate near-surface geologic strata and features. Typical survey deployments also include single beam or multibeam depth sounders and side-scan sonar. The AUV surveys for oil and gas leases include a similar equipment suite. These electromechanical sources may also be operated simultaneously with the airguns during deep penetration seismic surveys for oil and gas exploration purposes.

Boomers are electromechanical sound sources that generate short, broadband acoustic pulses that are useful for high-resolution, shallow penetration sediment profiling. This system is commonly mounted on a sled and towed off the stern or alongside the ship. The reflected signal is received by a towed hydrophone streamer. Chirp systems are used for high-resolution mapping of relatively shallow deposits and in general have less penetration than boomers; however, newer chirp systems are able to penetrate to levels comparable to the boomer yet yield extraordinary detail or resolution of the substrate (National Science Foundation [NSF] and USDOI, U.S. Geological Survey [USGS], 2011). Multibeam depth sounders emit brief pings of medium- or high-frequency sound in a fan-shaped beam extending downward and to the sides of the ship, allowing bathymetric mapping of swaths of the seafloor. Single beam depth sounders may also be used for seafloor mapping, but the multibeam depth sounder was selected as a representative source for the Programmatic EIS and is conservative from the standpoint of acoustic impacts.

Detailed acoustic characteristics of electromechanical sources are discussed in **Appendix D** of the Programmatic EIS. Electromechanical sources are considered mid- or high-frequency sources. They usually have one or two (sometimes three) main operating frequencies (**Table A-14**). The frequency ranges for representative sources are 200 Hz–16 kHz for the boomer; 100 kHz and 400 kHz for the side-scan sonar; 3.5 kHz, 12 kHz, and 200 kHz for the chirp subbottom profiler; and 240 kHz for the multibeam depth sounder. For all of these sources, the acoustic energy emitted outside the main operating frequency band is negligible, and therefore they can be considered narrow-band sources. High-frequency electromechanical sources can be highly directive, with beam widths as narrow as few degrees or less. Broadband source levels for the representative electromechanical sources analyzed in this BA range from 212-226 dB re 1 µPa at 1 m (**Table A-14**).

Table A-15 lists the estimated maximum ranges of Level A and Level B harassment of cetaceans by electromechanical sources, based on current NMFS criteria. The range of values reflects the various geographic and seasonal scenarios modeled for the Programmatic EIS. The 180-dB radius ranged from 38-45 m (125-148 ft) for the boomer and from 32-42 m (105-138 ft) for the chirp subbottom profiler. The 180-dB radius was 27 m (89 ft) for the multibeam depth sounder under all scenarios. The side-scan sonar had the largest 180-dB radius, ranging from 128-192 m (420-630 ft).

The initial 180-dB calculations in **Table A-15** were based on nominal source levels and did not take into account the pulse duration. As indicated in the table, the pulses produced by all of the electromechanical sources are much shorter than 1 s. As summarized by Au and Hastings (2008), when receiving tone pulses, the mammalian ear behaves like an integrator with an “integration time constant.” Energy is summed over the duration of a pulse until the pulse is longer than the integration time constant. Studies of bottlenose dolphins by Johnson (1968) indicate an integration time constant of approximately 100 ms. A 10-ms pulse with a received SPL of 180 dB re 1 μPa would be integrated over a 100-ms period, resulting in a 10-fold (10-dB) reduction. Using the assumption of a 100-ms integration time, the 180-dB radii for side-scan sonar and multibeam depth sounder were recalculated to account for short pulse duration, as shown in **Table A-15**. For the boomer and multibeam depth sounder, the recalculated 180-dB radius was <5 m under all scenarios. The recalculated 180-dB radius ranged from 65-96 m (213-315 ft) for the side-scan sonar and from 26-35 m (85-115 ft) for the chirp subbottom profiler. Specific considerations for each electromechanical source are discussed below.

Boomer. The frequency range of the representative boomer (200 Hz-16 kHz) is entirely within the hearing range of marine mammals. Based on a source level of 212 dB re 1 μPa, the 180-dB radius is estimated to range from 38-45 m (125-148 ft) for the various geographic and seasonal scenarios modeled. However, taking into account the short pulse duration (180 μs), the recalculated 180-dB radius is <5 m (16 ft) in all modeled scenarios (**Table A-15**).

Side-Scan Sonar. For the representative side-scan sonar, the 100-kHz operating frequency is within the hearing range of mid- and high-frequency cetaceans, but the 400-kHz frequency is above the range of all marine mammals. Based on a source level of 226 dB re 1 μPa, the 180-dB radius is estimated to range from 128-192 m (420-630 ft) for the various geographic and seasonal scenarios modeled. Taking into account the short pulse length of 20 ms, the recalculated 180-dB radius ranges from 65-96 m (213-315 ft) (**Table A-15**).

Chirp Subbottom Profiler. The representative chirp subbottom profiler operates at three frequencies: 3.5 kHz, 12 kHz, and 200 kHz. The highest frequency (200 kHz) is above the hearing range for all marine mammals. Based on a source level of 222 dB re 1 μPa, the 180-dB radius ranges from 32-42 m (105-138 ft) for the various geographic and seasonal scenarios modeled. Because the pulse length of 64 ms is relatively close to the 100 ms integration time assumed for the cetacean ear, the correction for pulse length reduces the ranges only slightly to 26-35 m (85-115 ft) (**Table A-15**).

Multibeam Depth Sounder. Based on a source level of 213 dB re 1 μPa, the 180-dB radius calculated for the multibeam depth sounder is 27 m (89 ft) for all of the geographic and seasonal scenarios modeled (**Table A-15**). Taking into account the short pulse duration (225 μs), the radius is further reduced to <5 m (16 ft) for all modeled scenarios. More importantly, because the operating frequency of the representative multibeam system (240 kHz) is above the hearing range of all three cetacean hearing groups, no auditory impacts are expected. The relatively low risk of auditory impacts on marine mammals from multibeam depth sounders is consistent with a recent analysis by Lurton and DeRuiter (2011) taking into account both the short pulse duration and high directivity of these sources.

5.2.1. Effects on Marine Mammals

Figure A-22 summarizes the relationship between the functional hearing ranges of marine mammals and various noise sources in the marine environment. Studies on the responses of animals to noise have shown widely varied responses, depending on the individual, age, gender, and the activity in which the animals were engaged (Richardson et al., 1995; Simmonds et al., 2003; NRC, 2005; Southall et al., 2007; Ellison et al., 2011). Where there is an overlap between noise sources and the frequencies of sound used by marine life, there is the potential for sound to interfere with important biological functions. Noise, either natural or anthropogenic, can adversely affect marine life in various ways. Four zones of influence from noise are offered by Richardson et al. (1995) and summarized by Gordon et al. (2004), including (1) zone of audibility – the area within which the sound is both above the animal's hearing threshold and detectable above background noise; (2) zone of responsiveness – the region within which behavioral responses in response to the sound occur; (3) zone of masking – the area within which the sound may mask biologically significant sounds; and (4) zone of hearing loss, discomfort, or injury – the area within which the sound level is sufficient to cause threshold shifts or hearing damage.

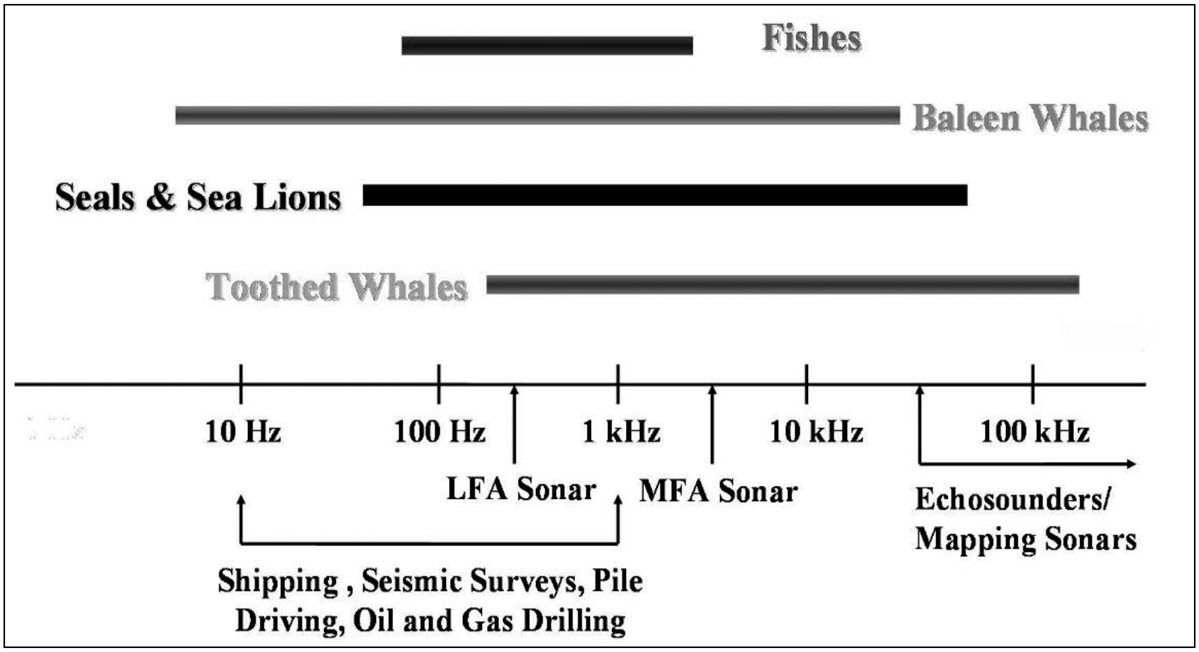


Figure A-22. Measured or Estimated Functional Hearing Ranges for Different Marine Vertebrate Groups Shown Relative to Various Human Noise Sources.

The range of potential effects from noise, in order of decreasing severity and modified slightly from the four zones initially outlined by Richardson et al. (1995) above, includes death, non-auditory physiological effects, auditory injury–hearing threshold shift, masking, and stress and disturbance, including behavioral response (Richardson et al., 1995; NRC, 2003, 2005; Nowacek et al., 2004; Southall et al., 2007). The following discussion addresses the range of potential effects noted above, with the exception of death and non-auditory physiological effects, which have been combined.

5.2.1.1. Death and Non-Auditory Physiological Effects

Although airguns produce high intensity sound pulses, there have been no observations of direct physical injury or death to marine mammals from exposure to these active acoustic sound sources. In addition, mitigation measures (see **Section 7**) would be implemented to decrease the potential for any marine mammal to be within the exclusion zone of an operating airgun array, thereby avoiding the highest SPLs and minimizing the potential for injury.

Injury and death of marine mammals has been observed in association with high intensity events such as underwaters explosions. These pulses are typically short, with peak pressures that may damage internal organs or air-filled body cavities (e.g., lungs) (Yelverton et al., 1973; Goertner, 1982; Young, 1991). Data on direct physical injury are limited to anecdotal or forensic investigations after accidental events because ethical considerations prevent direct empirical methods to measure such impacts in marine mammals. However, such observations (e.g., Todd et al., 1996) and modeling based on impact data for the human vestibular system as well as other organs (e.g., lungs) for underwater sound exposures (Cudahy and Ellison, 2002) suggest that marine mammals can be susceptible to direct physical injury to particular organ systems and tissues following intense exposure, particularly where high particle motion events occur. Possible types of non-auditory physiological effects or injuries that might occur include stress, neurological effects, bubble formation (which is a highly debated effect), resonance effects, and other types of organ or tissue damage. Based on some stranding observations coincidental to certain naval exercises, it is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strongly pulsed sounds, particularly at higher frequencies. However, is not likely that G&G activities would generate sounds loud enough to cause mortality or non-auditory injury.

5.2.1.2. Hearing Threshold Shift

Active acoustic sound sources used during G&G surveys have the potential to produce temporary threshold shift (TTS) or permanent threshold shift (PTS) in listed marine mammals if they are close to the source. Mitigation measures included in the proposed action (see **Section 7**) are intended to reduce the risk of marine mammals being present within the exclusion zone around airgun arrays where the potential for TTS and PTS would be greatest.

The minimum sound level an animal can hear at a specific frequency is the hearing threshold at that frequency. Sounds above a hearing threshold are accommodated until a certain level of sound intensity or duration is reached. Too much exposure at a certain level might cause a shift in the animal's hearing thresholds within a certain frequency range. Following exposure, the magnitude of the hearing impairment, or threshold shift, normally decreases over time following cessation of noise exposure. Threshold shifts can be temporary (TTS) or permanent (PTS), can consist of both temporary and permanent components, and are defined as follows, as adapted from Southall et al. (2007) and Finneran et al. (2005):

- TTS – the mildest form of hearing impairment; exposure to strong sound results in a non-permanent (reversible) elevation in hearing threshold, making it more difficult to hear sounds; TTS can last from minutes or hours to days; the magnitude of the TTS depends on the level and duration of the noise exposure, among other considerations.
- PTS – permanent elevation in hearing threshold; no data are currently available regarding noise levels that might induce PTS in marine mammals; PTS is attributed to exposure to very high peak pressures and short rise times, or very prolonged or repeated exposures to noise strong enough to elicit TTS.

Several important factors relate to the type and magnitude of hearing loss, including exposure level, frequency content, duration, and temporal pattern of exposure. A range of mechanical effects (e.g., stress or damage to supporting cell structure, fatigue) and metabolic processes (e.g., inner ear hair cell metabolism such as energy production, protein synthesis, and ion transport) within the auditory system underlie both TTS and PTS. Additional discussion of TTS and PTS is presented by Southall et al. (2007).

In June 1997, the High Energy Seismic Survey team (HESS, 1999) convened a panel of experts to assess existing data on marine mammals exposed to seismic airgun pulses and to predict exposures at which physical injury could occur. With the limited available data at that time, exposure to airgun pulses with received levels above 180 dB re 1 µPa (root-mean-square [rms] – averaged over the pulse duration) was determined to have a high potential for "serious behavioral, physiological, and hearing effects."

Based on the HESS (1999) panel conclusions, the NMFS established a 180 dB re 1 µPa (received level) threshold criterion for injury from sound exposure for cetaceans and a 190 dB re 1 µPa threshold criterion for pinnipeds. Calculated radial distances to the 180-dB isopleth are dependent upon the size and orientation of the array and physical characteristics of the marine environment and sediments (e.g., water column stratification, water depth and nature of the seafloor). Results of sound propagation modeling from sound sources associated with the proposed action are shown in **Table A-15**.

More recently, NMFS supported an expert working group to develop more comprehensive and current criteria. This process ultimately resulted in the Southall et al. (2007) marine mammal noise exposure criteria. Within this process, several important distinctions were made. First, the marine mammals were segregated into the functional hearing groups. Second, sound sources were categorized into functional categories, based on their acoustic and repetitive properties. The review indicated that the lowest received levels of impulsive sounds (e.g., airgun pulses) that might elicit slight auditory injury (PTS) are a sound exposure level (SEL) of 198 dB re 1 μPa^2-s in cetaceans and 186 dB re 1 μPa^2-s in pinnipeds. The noise criteria group also concluded that receipt of an instantaneous flat-weighted peak pressure exceeding 230 dB re 1 µPa (peak) for cetaceans or 218 dB re 1 µPa (peak) for pinnipeds might also lead to auditory injury even if the aforementioned cumulative energy-based criterion was not exceeded.

The SEL criterion as proposed by Southall et al. (2007) is advantageous because it can account for cumulative sound exposure, sounds of differing duration, and multiple sound exposures. It also allows comparison between different sound exposures based on total energy (i.e., calculation of a single exposure "equivalent" value; Southall et al., 2007). The NMFS continues to evaluate the SEL metric for marine mammal injury (i.e., TTS, PTS), but the current regulatory thresholds remain based on SPLs (i.e., 180/190 dB re 1 μPa for injury; 160 dB re 1 μPa for behavioral harassment).

5.2.1.3. Auditory Masking

Noise can affect hearing and partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and/or conspecific signals; and/or detect important environmental features associated with spatial orientation (Clark et al., 2009). Masking is defined as the obscuring of weaker sounds of interest by other, stronger, more intense sounds, often at similar frequencies. Spectral, temporal, and spatial overlap between the masking noise and the sender/receiver determines the extent of interference; the greater the spectral and temporal overlap, the greater the potential for masking.

Naturally occurring ambient noise is produced from various sources, including wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal noise resulting from molecular agitation (Richardson et al., 1995). Background noise can also include sounds from distant human activities (e.g., shipping), particularly in areas where heavy levels of shipping traffic are located. Ambient noise can produce masking, effectively interfering with the ability of an animal to detect a sound signal that it otherwise would hear. Under normal circumstances, in the absence of high ambient noise levels, an animal would hear a sound signal because it is above its absolute hearing threshold. Natural masking prevents a portion or all of that sound signal from being heard. Further masking of natural sounds can result when human activities produce high levels of background noise. Ambient noise is highly variable on continental shelves (e.g., see Desharnais et al., 1999), effectively creating a high degree of variability in the range at which marine mammals can detect anthropogenic sounds.

Toothed whales have the ability to facilitate the detection of sounds in the presence of background noise. There is evidence that some odontocetes can shift the dominant frequencies of their echolocation signals from a frequency range containing excessive ambient noise toward frequencies with less noise (Au et al., 1974, 1985; Moore and Pawloski, 1990; Thomas and Turl, 1990; Romanenko and Kitain, 1992; Lesage et al., 1999). Several marine mammal species are also known to increase the source levels of their calls in the presence of elevated sound levels (Dahlheim, 1987; Au, 1993; Lesage et al., 1999; Terhune, 1999). While data exist that demonstrate adaptation among odontocetes to reduce the effects of masking at high frequencies, there are fewer data sources available regarding corresponding mechanisms at moderate or low frequencies, or in mysticetes. Recent work by Clark et al. (2009) summarizes the potential for acoustic masking on baleen whales from anthropogenic sounds, including shipping. Castellote et al. (2010), studying fin whales in the eastern Atlantic and western Mediterranean, documented the shortening of low frequency (20 Hz) pulse duration, decreasing bandwidth, and decreasing center and peak frequencies as a result of masking from shipping (and seismic) activity. Directional hearing has been demonstrated at frequencies as low as 0.5-2 kHz in several marine mammals, including killer whales (see Richardson et al., 1995). This ability may be useful in reducing masking at these frequencies.

Sound sources used during G&G activities have the potential to mask marine mammal communication and monitoring of environmental cues if an individual is present within range of operational sound sources. The sound energy of the representative sources would be directed primiarly towards the seafloor, but reflected energy propagated horizontally away from the sources could result in masking. Low-frequency sound from airguns and vessels primarily overlaps with mysticete vocalizations, and the lower range of sperm whale and manatee vocalizations. Depth sounders and side-scan sonars overlap with sperm whale and manatee vocalizations. In general, because mysticetes may communicate over long distances, the potential for masking is greater. However, at this point, there has been only preliminary research into masking and its spatial extent (Clark et al., 2009).

Seismic survey protocols and mitigation procedures (**Section 7**) would be implemented to decrease the potential for any marine mammal to be within the exclusion zone of an operating airgun array, thereby reducing the potential for masking. While the full extent of the zone of masking has not been determined, it is expected that the exclusion zone encompasses a portion of the ensonification area where masking may occur. Section 7 also describes what is known on the effectiveness of these measures.

5.2.1.4. Behavioral Responses

Stress in marine mammals resulting from noise exposure typically involves the sympathetic nervous system. Stress response in marine mammals is immediate, acute, and characterized by the release of the neurohormones norepinephrine and epinephrine (i.e., catecholamines; U.S. Navy, Office of Naval Research, 2009). Various researchers (e.g., Romano et al., 2004) have summarized available evidence for profound activity during stressors such as stranding or predation (Cowan and Curry, 2008; Mashburn and Atkinson, 2008; Eskesen et al., 2009). Romano et al. (2004) note that no quantitative approach to estimating changes in mortality or fecundity because of stress has been identified and that qualitative effects may include increased susceptibility to disease and early termination of pregnancy.

Disturbance can induce a variety of effects including subtle changes in behavior, more conspicuous dramatic changes in activities, and displacement. Disturbance is one of the main concerns of the potential impacts of manmade noise on marine mammals. Richardson et al. (1995) noted that most small and medium-sized toothed whales exposed to prolonged or repeated underwater sounds are unlikely to be displaced unless the overall received level is at least 140 dB re 1 μPa. Limited available data indicate that sperm whales are sometimes, though not always, more responsive than other toothed whales to anthropogenic noise. Baleen whales probably have better hearing sensitivities at lower sound frequencies, and in several studies have been shown to react at received sound levels of approximately 120 dB re 1 μPa (e.g., 0.5 probability of avoidance by gray whales of a continuous noise source; Malme et al., 1988; also see Southall et al., 2007).

Behavioral responses of marine mammals to sound are difficult to predict because responses are dependent on numerous factors, including the species being evaluated; the animal's state of maturity, prior experience and exposure to anthropogenic sounds, current activity patterns, and reproductive state; time of day; and weather state (Wartzok et al., 2004). If a marine mammal reacts to an underwater sound by changing its behavior or moving to avoid a sound source, the impacts of that change may not be important to the individual, the stock, or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on both individuals and the population could be important.

There is a very wide range of possible behavioral responses to sound exposure, given that the sound is audible to the particular animal, including, in approximate order of increasing severity but decreasing likelihood, the following:

- none observable – animals can become less sensitive over repeated exposures;
- looking at the sound source or increased alertness;
- minor behavioral responses such as vocal modifications associated with masking;
- cessation of feeding or social interactions;
- temporary avoidance behavior (emerging as one of the more common responses);
- modification of group structure or activity state; and/or
- habitat abandonment.

Assessing the severity of behavioral effects of anthropogenic sound exposure on marine mammals presents unique challenges associated with the inherent complexity of behavioral responses and the contextual factors affecting them, both within and between individuals and species. Severity of responses can vary depending on characteristics of the sound source (e.g., moving or stationary, number and spatial distribution of sound source[s], similarity to predator sounds, and other relevant factors) (Richardson et al., 1995; NRC, 2005; Southall et al., 2007; Wirsing et al., 2008; Bejder et al., 2009; Barber et al., 2010; Ellison et al., 2011).

There is considerable available literature on the effects of noise on marine mammal behavior (see Southall et al., 2007). Traveling blue and fin whales exposed to seismic noise from airguns have been reported to stop emitting redundant songs (McDonald et al., 1995; Clark and Gagnon, 2006). By contrast, Di Iorio and Clark (2010) found increased production of transient, non-redundant calls during seismic sparker operations, suggesting that blue whales respond to noise interference according to the context and the signal produced. They further postulated that animals engaged in near-term, proximate communication are probably afforded an advantage in acoustic behaviors that maintain the immediate social link; for animals engaged in long-term singing directed to a distant audience, information loss is minor if singing is temporarily interrupted. Di Iorio and Clark (2010) determined that blue whales changed their calling behavior in response to a low frequency, low output sound source that was previously presumed to have minor environmental impact (Duchesne et al., 2007). The mean sound pressure was relatively low, 131 dB re 1 µPa (peak to peak) (30-500 Hz) with a mean SEL of 114 dB re 1 μPa^2 s (90 percent energy approach for duration estimate; Madsen, 2005). There are insufficient data to determine the relevance of the observed vocal adjustment to an individual whale's well-being.

North Atlantic right whales exhibited changes in diving behavior when exposed to an alert signal at received levels of 133-148 dB re 1 µPa (Nowacek et al., 2004). Blue whales responded to noise from seismic sparker operations by increasing call production. Observed responses of cetaceans to airgun activity include reduced vocalization rates (e.g., Goold, 1996) but no vocal changes (e.g., Madsen et al., 2002) or cessation of singing (e.g., McDonald et al., 1995). Other short-term vocal adjustments observed across taxa exposed to elevated ambient noise levels include shifting call frequency, increasing call amplitude or duration, and ceasing to call (Nowacek et al., 2007). In baleen whales, North Atlantic right whales exposed to high shipping noise increased call frequency (Parks et al., 2007), while some humpback whales responded to low frequency active sonar playbacks by increasing song length (Miller et al., 2000).

It is apparent that there is significant species-specific variability in the behavioral responses of marine mammals to noise exposure, including several different active acoustic sound sources. It is also evident that there is a broad spectrum of behavioral responses, each of which has varying importance to the individual. Recognizing these issues, Southall et al. (2007) concluded (1) that there are many more published accounts of behavioral responses to noise by marine mammals than of direct auditory or physiological effects; (2) available data on behavioral responses do not converge on specific exposure conditions resulting in particular reactions, nor do they point to a common behavioral mechanism; (3) study data obtained with substantial controls, precision, and standardized metrics indicate high variance both in behavioral responses and in exposure conditions required to elicit a given response; and (4) distinguishing a significant behavioral response from an insignificant, momentary alteration in behavior is difficult.

Sound sources used during G&G activities have the potential to produce stress, disturbance, and behavioral responses in marine mammals if they are present within range of the operational airgun array. Mitigation measures included in the proposed action would minimize the potential for any marine mammal to be within the exclusion zone of an operating sound source, thereby reducing the potential for behavioral responses in close proximity to the sound source. However, beyond the exclusion zone, some behavioral responses may occur.

5.2.1.5. Indirect Effects Mediated by Prey Availability

Short-term, indirect effects on marine mammals could occur as a result of acoustic impacts on, or behavioral responses of, prey species (e.g., squid) in the immediate vicinity of seismic airgun surveys. Based on a review of airgun impacts on invertebrates by Christian and Bocking (2011), studies to date have not revealed any consistent evidence of serious pathological or physiological effects on invertebrates. Any effects, including behavioral responses, would be localized (near survey vessels) and transient. With the seismic source vessel moving at speeds of about 4.5 kn (8.3 km/hr), the vessel and its streamers would pass any given point within about an hour. If prey species avoided an area in which a survey was being performed, it would represent a very small portion of a marine mammal's foraging range. Any indirect impacts on prey behavior would not be expected to significantly affect any of the listed marine mammals.

5.2.1.6. Analysis of the Proposed Action Scenario

The proposed action includes extensive seismic airgun surveys during the 2012-2020 time period, as discussed in **Section 2.2.2.1**. These include 617,775 line km of 2D surveys, 2,500 blocks of 3D surveys, 900 line km of 3D WAZ and FAZ coil surveys, 1,280 line km of VSP surveys, and 175,465 line km of HRG surveys (**Table A-11**). All of these surveys are within the oil and gas exploration program, as airguns are not used on HRG surveys for marine minerals programs and are highly unlike for use in renewable energy programs. The renewable energy scenario does include the possibility that a deep penetration (2D or 3D) seismic survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic airgun survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

The proposed action also includes HRG surveys for renewable energy and marine minerals programs as described in **Sections 2.2.3** and **2.2.4**; activity levels for the 2012-2020 time period are provided in **Tables A-5** and **A-6**. These surveys are expected to use only electromechanical sound sources (e.g., boomer and chirp subbottom profilers, side-scan sonars, and multibeam depth sounders).

Incidental take of marine mammals, including listed species, was estimated for the proposed action scenario as described in **Appendix E** of the Programmatic EIS. The calculations used the Acoustic Integration Model© (AIM), which is a 4D, individual-based, Monte Carlo statistical model designed to predict the exposure of receivers to any stimulus propagating through space and time. The modeling used both the current NMFS criteria for Level A and Level B harassment, as well as the Southall et al. (2007) criteria for injury (Level A harassment). The incidental take estimates are based solely on the activity scenario, source characteristics, and seasonal marine mammal densities; although the right whale time-area closure was taken into account, the operational mitigation measures included in the seismic airgun survey protocol and HRG survey protocol (see **Section 7**) were not incorporated into the modeling. This means that marine mammals could be counted as Level A takes even though mitigation measures could prevent those takes (e.g., if a marine mammal were detected approaching the exclusion zone, causing shutdown of the airgun array).

Table A-16 summarizes the results of the incidental take modeling for listed marine mammals, including all active acoustic sound sources (airguns, boomer and chirp subbottom profilers, side-scan sonars, and multibeam depth sounders) and all survey types. For the summary table, annual take estimates were calculated (as numbers of individuals) to three decimal places, and values were rounded to the nearest whole number of individuals. The grand total is the sum of the rounded annual values. Supporting tables are provided for seismic airgun surveys (**Table A-17**) and non-airgun HRG surveys (**Table A-18**). The fractional individuals in all of the tables are a result of the calculation process (e.g., use of mean densities) and do not represent probabilities.

Table A-16

Estimated Annual Incidental Takes of Listed Marine Mammals Due to All Active Acoustic Sound Sources in the Proposed Action, Including Both Seismic Airgun Surveys and Non-Airgun Surveys. Annual numbers of individuals taken were calculated to three decimal places, and values were rounded to the nearest whole number of animals. The total is the sum of the rounded annual values.[1] Source: **Appendix E** of the Programmatic EIS.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Level A Harassment Takes (180-dB NMFS criterion)										
North Atlantic Right Whale	**0** 0.002	**1** 1.164	**2** 2.293	**0** 0.271	**2** 1.885	**1** 1.397	**1** 1.299	**1** 0.877	**1** 0.604	**9**
Blue Whale	**0** 0.001	**2** 2.183	**4** 4.275	**0** 0.452	**3** 2.754	**2** 2.002	**2** 1.541	**1** 0.883	**1** 0.540	**15**
Fin Whale	**0** 0.001	**4** 4.401	**9** 8.639	**1** 0.951	**6** 5.898	**4** 4.344	**3** 3.478	**2** 1.926	**1** 1.228	**30**
Sei Whale	**0** 0.000	**2** 1.966	**4** 3.855	**0** 0.417	**3** 2.565	**2** 1.881	**1** 1.477	**1** 0.819	**1** 0.504	**14**
Humpback Whale	**0** 0.003	**6** 5.900	**12** 11.546	**1** 1.210	**7** 7.336	**5** 5.318	**4** 4.047	**2** 2.321	**1** 1.392	**38**
Sperm Whale	**0** 0.000	**159** 158.828	**310** 309.724	**30** 30.401	**179** 179.051	**127** 126.960	**89** 89.385	**55** 54.767	**30** 29.976	**979**
Florida Manatee	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0**
Level A Harassment Takes (Southall et al. 2007 criterion)										
North Atlantic Right Whale	**0** 0.002	**0** 0.039	**0** 0.074	**0** 0.011	**0** 0.047	**0** 0.036	**0** 0.025	**0** 0.009	**0** 0.001	**0**
Blue Whale	**0** (0.000)	**1** 0.831	**2** 1.623	**0** 0.164	**1** 0.915	**1** 0.664	**0** 0.439	**0** 0.208	**0** 0.043	**5**
Fin Whale	**0** 0.015	**0** 0.021	**0** 0.021	**0** 0.021	**0** 0.021	**0** 0.018	**0** 0.005	**0** 0.000	**0** 0.000	**0**
Sei Whale	**0** 0.002	**0** 0.211	**0** 0.405	**0** 0.035	**0** 0.178	**0** 0.115	**0** 0.057	**0** 0.060	**0** 0.030	**0**
Humpback Whale	**0** 0.000	**3** 3.046	**6** 5.931	**1** 0.567	**3** 3.153	**2** 2.226	**1** 1.402	**1** 0.779	**0** 0.235	**17**
Sperm Whale	**0** 0.001	**0** 0.096	**0** 0.185	**0** 0.016	**0** 0.077	**0** 0.051	**0** 0.021	**0** 0.019	**0** 0.001	**0**
Florida Manatee	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0**
Level B Harassment Takes (160-dB NMFS criterion)										
North Atlantic Right Whale	**0** 0.194	**114** 114.092	**225** 224.739	**27** 26.592	**185** 184.766	**137** 136.944	**127** 127.334	**86** 85.913	**59** 59.169	**960**
Blue Whale	**0** 0.066	**214** 213.999	**419** 418.979	**44** 44.264	**270** 269.881	**196** 196.170	**151** 150.994	**86** 86.495	**53** 52.877	**1,433**
Fin Whale	**0** 0.115	**431** 431.364	**847** 846.749	**93** 93.167	**578** 578.072	**426** 425.755	**341** 340.840	**189** 188.785	**120** 120.395	**3,025**
Sei Whale	**0** 0.036	**193** 192.672	**378** 377.852	**41** 40.901	**251** 251.373	**184** 184.310	**145** 144.793	**80** 80.298	**49** 49.415	**1,321**
Humpback Whale	**0** 0.245	**578** 578.293	**1,132** 1131.575	**119** 118.608	**719** 718.954	**521** 521.193	**397** 396.647	**227** 227.499	**136** 136.417	**3,829**
Sperm Whale	**0** 0.018	**15,567** 15566.727	**30,356** 30356.018	**2,980** 2979.633	**17,549** 17548.762	**12,443** 12443.391	**8,761** 8760.616	**5,368** 5367.671	**2,938** 2937.989	**95,962**
Florida Manatee	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0** (0.000)	**0**

[1] Both annual and total values could include multiple "takes" of the same individuals.

Table A-17

Estimated Annual Incidental Takes of Listed Marine Mammals Due to Seismic Airgun Surveys Included in the Proposed Action. Values are Total Numbers of Individuals. Source: **Appendix E** of the Programmatic EIS.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020
Level A Harassment Takes (180-dB NMFS criterion)									
North Atlantic Right Whale	**0** 0.000	**1** 1.162	**2** 2.290	**0** 0.269	**2** 1.883	**1** 1.395	**1** 1.294	**1** 0.874	**1** 0.595
Blue Whale	**0** 0.000	**2** 2.182	**4** 4.274	**0** 0.451	**3** 2.753	**2** 2.000	**2** 1.539	**1** 0.882	**1** 0.537
Fin Whale	**0** 0.000	**4** 4.400	**9** 8.638	**1** 0.949	**6** 5.896	**4** 4.342	**3** 3.474	**2** 1.924	**1** 1.223
Sei Whale	**0** 0.000	**2** 1.965	**4** 3.855	**0** 0.417	**3** 2.564	**2** 1.880	**1** 1.476	**1** 0.818	**1** 0.502
Humpback Whale	**0** 0.000	**6** 5.897	**12** 11.542	**1** 1.207	**7** 7.332	**5** 5.314	**4** 4.043	**2** 2.319	**1** 1.385
Sperm Whale	**0** 0.000	**159** 158.828	**310** 309.723	**30** 30.401	**179** 179.051	**127** 126.956	**89** 89.342	**55** 54.729	**30** 29.855
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Level A Harassment Takes (Southall et al. 2007 criterion)									
North Atlantic Right Whale	**0** 0.000	**0** 0.036	**0** 0.071	**0** 0.008	**0** 0.045	**0** 0.034	**0** 0.024	**0** 0.009	**0** 0.001
Blue Whale	**0** 0.000	**1** 0.831	**2** 1.622	**0** 0.164	**1** 0.915	**1** 0.663	**0** 0.439	**0** 0.208	**0** 0.043
Fin Whale	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Sei Whale	**0** 0.000	**0** 0.208	**0** 0.402	**0** 0.032	**0** 0.176	**0** 0.113	**0** 0.057	**0** 0.060	**0** 0.030
Humpback Whale	**0** 0.000	**3** 3.046	**6** 5.931	**1** 0.567	**3** 3.153	**2** 2.226	**1** 1.402	**1** 0.779	**0** 0.235
Sperm Whale	**0** 0.000	**0** 0.095	**0** 0.184	**0** 0.015	**0** 0.076	**0** 0.050	**0** 0.021	**0** 0.019	**0** 0.001
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Level B Harassment Takes (160-dB NMFS criterion)									
North Atlantic Right Whale	**0** 0.000	**114** 113.846	**224** 224.490	**26** 26.343	**185** 184.517	**137** 136.675	**127** 126.832	**86** 85.613	**58** 58.299
Blue Whale	**0** 0.000	**214** 213.901	**419** 418.875	**44** 44.161	**270** 269.778	**196** 196.066	**151** 150.850	**86** 86.408	**53** 52.620
Fin Whale	**0** 0.000	**431** 431.204	**847** 846.583	**93** 93.001	**578** 577.905	**426** 425.583	**341** 340.531	**189** 188.601	**120** 119.857
Sei Whale	**0** 0.000	**193** 192.625	**378** 377.801	**41** 40.850	**251** 251.322	**184** 184.255	**145** 144.677	**80** 80.219	**49** 49.182
Humpback Whale	**0** 0.000	**578** 577.964	**1,131** 1,131.230	**118** 118.264	**719** 718.609	**521** 520.862	**396** 396.288	**227** 227.280	**136** 135.768
Sperm Whale	**0** 0.000	**15,567** 15,566.706	**30,356** 30,355.996	**2,980** 2,979.611	**17,549** 17,548.740	**12,443** 12,442.986	**8,756** 8,756.403	**5,364** 5,363.975	**2,926** 2,926.098
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000

Table A-18

Estimated Annual Incidental Takes of Listed Marine Mammals Due to Non-Airgun High Resolution Geophysical Surveys included in the Proposed Action. Values are Total Numbers of Individuals. Source: **Appendix E** of the Programmatic EIS.

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020
Level A Harassment Takes (180-dB NMFS criterion)									
North Atlantic Right Whale	**0** 0.0020	**0** 0.0025	**0** 0.0025	**0** 0.0025	**0** 0.0025	**0** 0.0027	**0** 0.0051	**0** 0.0031	**0** 0.0089
Blue Whale	**0** 0.0007	**0** 0.0010	**0** 0.0011	**0** 0.0011	**0** 0.0011	**0** 0.0011	**0** 0.0015	**0** 0.0009	**0** 0.0026
Fin Whale	**0** 0.0012	**0** 0.0016	**0** 0.0017	**0** 0.0017	**0** 0.0017	**0** 0.0018	**0** 0.0031	**0** 0.0019	**0** 0.0055
Sei Whale	**0** 0.0004	**0** 0.0005	**0** 0.0005	**0** 0.0005	**0** 0.0005	**0** 0.0006	**0** 0.0012	**0** 0.0008	**0** 0.0024
Humpback Whale	**0** 0.0025	**0** 0.0034	**0** 0.0035	**0** 0.0035	**0** 0.0035	**0** 0.0034	**0** 0.0037	**0** 0.0022	**0** 0.0066
Sperm Whale	**0** 0.0002	**0** 0.0002	**0** 0.0002	**0** 0.0002	**0** 0.0002	**0** 0.0041	**0** 0.0430	**0** 0.0377	**0** 0.1213
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Level A Harassment Takes (Southall et al. 2007 criterion)									
North Atlantic Right Whale	**0** 0.0021	**0** 0.0026	**0** 0.0026	**0** 0.0026	**0** 0.0026	**0** 0.0022	**0** 0.0005	**0** 0.000	**0** 0.000
Blue Whale	**0** 0.0002	**0** 0.0005	**0** 0.0005	**0** 0.0005	**0** 0.0005	**0** 0.0005	**0** 0.0003	**0** 0.000	**0** 0.000
Fin Whale	**0** 0.0155	**0** 0.0208	**0** 0.0208	**0** 0.0208	**0** 0.0208	**0** 0.0185	**0** 0.0053	**0** 0.000	**0** 0.000
Sei Whale	**0** 0.0020	**0** 0.0024	**0** 0.0024	**0** 0.0024	**0** 0.0024	**0** 0.0021	**0** 0.0004	**0** 0.000	**0** 0.000
Humpback Whale	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Sperm Whale	**0** 0.0008	**0** 0.0009	**0** 0.0009	**0** 0.0009	**0** 0.0009	**0** 0.0008	**0** 0.0001	**0** 0.000	**0** 0.000
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000
Level B Harassment Takes (160-dB NMFS criterion)									
North Atlantic Right Whale	**0** 0.1945	**0** 0.2461	**0** 0.2491	**0** 0.2491	**0** 0.2491	**0** 0.2690	**1** 0.5016	**0** 0.3002	**1** 0.8702
Blue Whale	**0** 0.0659	**0** 0.0980	**0** 0.1037	**0** 0.1037	**0** 0.1037	**0** 0.1048	**0** 0.1448	**0** 0.0871	**0** 0.2568
Fin Whale	**0** 0.1153	**0** 0.1598	**0** 0.1665	**0** 0.1665	**0** 0.1665	**0** 0.1722	**0** 0.3083	**0** 0.1847	**1** 0.5384
Sei Whale	**0** 0.0358	**0** 0.0476	**0** 0.0511	**0** 0.0511	**0** 0.0511	**0** 0.0557	**0** 0.1152	**0** 0.0784	**0** 0.2328
Humpback Whale	**0** 0.2454	**0** 0.3285	**0** 0.3444	**0** 0.3444	**0** 0.3444	**0** 0.3313	**0** 0.3597	**0** 0.2189	**1** 0.6492
Sperm Whale	**0** 0.0182	**0** 0.0215	**0** 0.0215	**0** 0.0215	**0** 0.0215	**0** 0.4051	**4** 4.2127	**4** 3.6965	**12** 11.8913
Florida Manatee	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000	**0** 0.000

Level A Harassment

The modeling predicts Level A harassment of all listed species except the Florida manatee (all values are zero due to low densities in the BA Area) (**Table A-16**). Using the 180 dB re 1 µPa criterion, the sperm whale has the largest number of Level A takes (0-310 individuals per year), whereas all other species have fewer than 12 individuals taken per year. Using the Southall et al. (2007) criteria, all species are predicted to have fewer than six individuals taken per year, and all except the blue whale and humpback whale are predicted to have much less than one individual per year (rounded to zero). The difference reflects the higher threshold for Level A harassment in the Southall et al. (2007) criteria, as well as the consideration of the different functional hearing groups. For example, the reduction in number of takes was much more pronounced for sperm whales because as mid-frequency specialists they are less likely to be affected by low-frequency airgun pulses (in contrast to mysticete whales, which are low-frequency specialists).

The NMFS Level A criterion is not based on a specific injury (e.g., PTS), but more broadly on SPLs that are "likely to have the potential to cause serious behavioral, physiological and hearing effects" (HESS, 1999). Based on the Southall et al. (2007) injury criteria, the risk of actual injury (as estimated by the number of takes) is much lower and nearly zero for most species.

The proposed action includes a time-area closure (see **Section 7**) that has been factored into the incidental take calculations. The Level A incidental takes of North Atlantic right whales are approximately 67 percent lower than they would be without the time-area closure. However, the modeling does not take into account the operational mitigation measures to ensure that marine mammals are not present within the 180-dB exclusion zone. Although these measures may not be 100 percent effective, they would be expected to significantly reduce the risk of Level A harassment to marine mammals.

Level B Harassment

The modeling also predicts Level B harassment of all of the listed marine mammal species except the Florida manatee (**Table A-16**). The sperm whale is predicted to have the largest number of Level B harassment takes (up to 30,356 individuals per year), and the North Atlantic right whale has the smallest number (0-225 individuals per year). The results primarily reflect differences in the densities of the species modeled within the BA Area, as differences in functional hearing group are not taken into account in the 160-dB re 1 µPa criterion.

The proposed action includes a time-area closure (see **Section 7**) that has been factored into the incidental take calculations. The Level B incidental takes of North Atlantic right whales are approximately 67 percent lower than they would be without the time-area closure. In addition, the operational mitigation measures to ensure that marine mammals are not present within the exclusion zone may also help to reduce the number of Level B harassment takes, but this has not been quantified in the modeling.

Relative Effects of Airguns vs. Electromechanical Sources

Incidental takes from airguns (during seismic airgun surveys) and electromechanical sources (during non-airgun HRG surveys) are summarized in **Tables A-17** and **A-18**, respectively. It should be noted that electromechanical sources could be operating concurrently with airguns during seismic airgun surveys, but any incidental takes are assumed to be accounted for by the airgun calculations.

Except for 2012 when only non-airgun HRG surveys are expected to be conducted, seismic airgun surveys are expected to account for more than 99 percent of the incidental takes of each species during a given year. Non-airgun HRG surveys are expected to result in essentially zero Level A takes using either the NMFS 180-dB criterion or the Southall et al. (2007) criteria (**Table A-18**).

Non-airgun HRG surveys could result in a few Level B harassment takes (**Table A-18**). For blue whale, sei whale, and the Florida manatee, the values are less than one individual per year throughout the 2012-2020 period (assuming annual values would be rounded to the nearest whole number). Non-zero Level B harassment takes were predicted for the sperm whale (0-12 individuals per year), North Atlantic right whale (0-1 individuals per year), fin whale (0-1 individuals per year), and humpback whale (0-1 individuals per year).

Among the representative electromechanical sources, boomers and multibeam depth sounders pose the smallest risk of auditory impacts to marine mammals. Under all scenarios modeled, the 180-dB radius for both sources is estimated to be <50 m (160 ft) for the nominal source level and <5 m (16 ft) when pulse duration is taken into account (**Table A-15**). Based on the Southall criteria, the predicted injury radius would be zero for both sources. In addition, the operating frequency of the representative multibeam depth sounder is beyond the range of all three cetacean groups. (Some multibeam depth sounders use different frequencies that are within the cetacean hearing range, but the system modeled here is considered representative of the equipment likely to be used during HRG surveys for renewable energy and marine minerals sites.)

Both the representative side-scan sonar and chirp subbottom profiler could be detectable by cetaceans, depending on the operating frequencies selected. The side-scan sonar operating at 100 kHz would be detectable, and the 180-dB radius is estimated to be 128-192 m (420-630 ft) based on the nominal source level and 65-96 m (213-315 ft) when the short pulse length is taken into account. The chirp subbottom profiler operating at either 3.5 kHz or 12 kHz would be detectable, and the 180-dB radius is estimated to be 32-42 m (105-138 ft) based on the nominal source level and 26-35 m (85-115 ft) when the short pulse length is taken into account. Based on the Southall criteria, predicted injury ranges are less than 10 m (33 ft) for both sources.

For non-airgun HRG surveys using only electromechanical sources, depending on the suite of equipment selected and the operating frequencies selected, there may be no risk of Level A or B harassment of marine mammals. For example, if a survey uses side-scan sonar at 400 kHz, chirp subbottom at 200 kHz, multibeam depth sounder at 240 kHz, and no boomer, then no acoustic harassment of marine mammals would be expected.

Multiple Exposures to Airgun Pulses

The incidental take modeling includes the potential for multiple exposures of individual marine animals in numerous ways. For example, in the modeling of the WAZ surveys, the received "ping" or transmitted signal history for all modeled animals (called "animats" in AIM) is recorded for two sources operating simultaneously in the simulation. Since most of the take criteria (i.e., the historic 160-dB and 180-dB NMFS criteria and the Southall Level A SPL threshold) depend on the strongest signal received by each animat, only the Southall SEL criterion would incorporate effects of multiple pings. Similarly, for most of the surveys examined in this analysis, the AIM modeling keeps track of the multiple exposures of each animat, whether it is from an airgun array firing every 10-15 s as it approaches that animat during a single survey leg, or if it is from multiple legs of a survey, or from multiple passes of a side-scan sonar or multiple beams from a multi-beam system; all of these exposures are recorded and analyzed.

An examination of the raw data from the analysis indicates that with the exception of the case of multiple pings received during the approach of a source during a single leg of the survey, only a relatively small number (nominally less than about 10 percent) of animats remain in the same area or vicinity long enough to allow multiple legs (lines) of a survey to affect them more than once. Most of these animats would have moved far enough from the survey legs that if their received levels were greater than 155-160 dB re 1 µPa, the next highest received levels would 20 dB re 1 µPa or more below this. These cases occur for different animats throughout the timeline of the simulation. It should be noted that the movement of the modeled animats is random (i.e., they have not been programmed to avoid active acoustic sound sources, even though they could do so in the real world).

Because the proposed action includes surveys over a period of several years (2012-2020), it is also possible that some of the same animals could be affected during more than one year.

Conclusions

Active acoustic sound sources used during G&G surveys are likely to adversely effect ESA-listed whales species as they could result in Level A and Level B incidental takes The most likely effects would be behavioral responses (Level B harassment) caused by exposure to airgun pulses. The risk of injury, as estimated using the Southall et al. (2007) injury criteria, is very low and nearly zero for most species.

Because of the operational mitigation measures that would be implemented during seismic airgun surveys and non-airgun HRG surveys, Level A harassment is expected to be avoided to the maximum extent practicable; however, the actual mitigation effectiveness and reduction of incidental takes have not been estimated. See **Section 7.1.2.6** for a brief discussion of mitigation effectiveness.

Based on the current NMFS criteria, seismic airgun surveys could result in Level A takes of all listed marine mammals except the Florida manatee. The sperm whale is estimated to have the largest number of Level A takes (0-310 individuals per year), whereas all other species would have fewer than 12 individuals taken per year. In contrast, the Southall et al. 2007 criteria would only result in potential Level A takes of blue and humpback whales.

Nearly all of the incidental takes would be caused by airguns, which would be used extensively for surveys in the oil and gas program and which produce pulses that are within the functional hearing range of all marine mammals. Non-airgun HRG surveys are not expected to result in any Level A takes, but could result in a few Level B harassment takes, mainly of sperm whales.

Approximately two-thirds of the potential incidental takes of North Atlantic right whales (and some takes of other listed whales) are expected to be avoided by the time-area closure included in the proposed action. Florida manatees are unlikely to come into contact with active acoustic sound sources, and no effects to manatees are expected.

5.2.2. Effects on Sea Turtles

Few studies have examined the role acoustic cues play in the ecology of sea turtles (Mrosovsky, 1972; Samuel et al., 2005; Nunny et al., 2008). There is evidence that sea turtles may use sound to communicate; the few vocalizations described for sea turtles are restricted to the “grunts” of nesting females (Mrosovsky, 1972). These sounds are low frequency and relatively loud, thus leading to speculation that nesting females use sounds to communicate with conspecifics (Mrosovsky, 1972). Little is known about the extent to which sea turtles use their auditory environment. However, the passive acoustic environment for sea turtles changes with each ontogenetic habitat shift. In the inshore environment where juvenile and adult sea turtles generally reside, the ambient environment is noisier than the open ocean environment of the hatchlings; this inshore environment is dominated by low frequency sound (Hawkins and Myrberg, 1983), and, in highly trafficked areas, virtually constant low frequency noises from shipping, recreational boating, and other sources compound the potential for acoustic impact (Hildebrand, 2009).

Active acoustic sound sources could have a range of effects on sea turtles. In order of decreasing severity, these could include death, physical injury, hearing threshold shift, auditory masking, and behavioral responses. Hearing threshold shifts, auditory masking, and behavioral responses are discussed in detail below. There are no data demonstrating death or injury of sea turtles from airguns, which are the sound sources with the highest source levels. Behavioral responses are the most likely impact, with a limited potential for hearing threshold shift and masking effects for sea turtles close to an airgun array.

5.2.2.1. Death or Injury

Injury and death of sea turtles has been observed in association with high intensity events such as underwater explosions (O’Keeffe and Young, 1984; Klima et al., 1988). Underwater explosions produce pulses with very steep rise times and peak pressures that may damage internal organs or air-filled body cavities (e.g., lungs) (Yelverton et al., 1973; Goertner, 1982; Young, 1991). Airgun pulses do not produce the same kinds of physical impacts. If the Southall et al. (2007) marine mammal injury criteria are applied to sea turtles, then the risk of injury is very low. In addition, mitigation measures (see **Section 7**) would be implemented to decrease the potential for sea turtles to be within the exclusion zone of an operating airgun array, thereby avoiding the highest SPLs and minimizing the potential for death or injury.

5.2.2.2. Hearing Threshold Shift

Auditory impacts such as TTS or PTS could occur in sea turtles. However, unlike marine mammals, criteria have not been developed for these effects in sea turtles, mainly because of the few data that exist on their hearing. By definition, TTS is a temporary and recoverable damage to hearing structures (sensory hair cells) and can vary in intensity and duration. For individuals experiencing TTS, normal hearing abilities would return over time; however, animals may lack the ability to detect prey and predators and assess their environment during the recovery period. In contrast, PTS results in the permanent though variable loss of hearing through the loss of sensory hair cells (Clark, 1991). Few studies have looked at hair cell damage in reptiles, and studies do not indicate precisely if sea turtles are able to regenerate injured sensory hair cells (Warchol, 2011).

Because there are no hearing criteria for sea turtles, NMFS typically applies the criteria for marine mammals to evaluate the potential for similar impacts. The current NMFS criterion for Level A harassment of cetaceans is a received SPL of 180 dB re 1 µPa; although not explicitly referring to TTS or PTS, this criterion is based on the potential for “overt behavioral, physiological, and hearing effects on marine mammals in general” (HESS, 1999). Calculations indicate that this zone could extend up to 2.1 km (1.3 mi) from a large airgun array (5,400 in.^{3}) and up to 186 m (610 ft) from a small airgun array (90 in.^{3}) (**Table A-15**); however, the actual extent of the injury zone is likely to be much smaller than this. Southall et al. (2007) proposed two auditory injury criteria for cetaceans, one based on SEL and the other based on a received SPL of 230 dB re 1 µPa (peak). The 230 dB re 1 µPa level would occur within a few meters of the center of an airgun array. If auditory threshold shifts occur at similar received levels in sea turtles, the actual risk of auditory system impacts is likely to be limited to areas within an airgun array.

5.2.2.3. Auditory Masking

Noise below the TTS and PTS levels may have the potential to mask relevant sounds in the environment or induce simple behavioral changes in sea turtles such as evasive maneuvers (e.g., diving or changes in swimming direction and/or speed). Masking sounds can interfere with the acquisition of prey or mates, the avoidance of predators, and, in the case of sea turtles, the identification of an appropriate nesting site (Nunny et al., 2008). These maskers could have diverse origins, ranging from natural to anthropogenic sounds (Hildebrand, 2009). Because sea turtles appear to be low frequency specialists, the potential masking noises would fall mainly within the range of 50-1,000 Hz. There are no quantitative data demonstrating masking effects for sea turtles. Because few studies have examined the role acoustic cues play in the ecology of sea turtles, it is difficult to predict whether masking would have any ecological consequences for sea turtles.

5.2.2.4. Behavioral Responses

Limited data exist on noise levels that may induce behavioral changes in sea turtles. Avoidance responses to seismic signals have been observed at levels between 166 and 179 dB re 1 µPa (Moein et al., 1995; McCauley et al., 2000); however, both of these studies were done in a caged environment, so the extent of avoidance could not be monitored. In experiments attempting to use airguns to repel turtles from dredging operations, Moein et al. (1995) observed a habituation effect to airguns; the animals stopped responding to the signal after three presentations. From these results, it was not clear whether this lack of behavioral response was a result of behavioral habituation, or physical effects from TTS or PTS.

5.2.2.5. Indirect Effects Mediated by Prey Availability

Short-term, indirect effects on sea turtles could occur as a result of acoustic impacts on, or behavioral responses of, prey species in the immediate vicinity of seismic airgun surveys. Adult loggerheads feed primarily on benthic molluscs and crustaceans. Leatherbacks are pelagic feeders, preferring coelenterates (jellyfish). Based on a review of airgun impacts on invertebrates by Christian and Bocking (2011), studies to date have not revealed any consistent evidence of serious pathological or physiological effects on invertebrates. With the seismic source vessel moving at speeds of about 4.5 kn (8.3 km/hr), the vessel and its streamers would pass any given point within about an hour. If prey species avoided an area in which a survey was being performed, it would represent a very small portion of a sea turtle’s foraging range. Any indirect impacts on prey behavior would be expected to effect but not adversely effect listed sea turtles.

5.2.2.6. Analysis of the Proposed Action Scenario

The proposed action includes extensive seismic airgun surveys during the 2012-2020 time period, as discussed in **Section 2.2.2.1**. These include 617,775 line km of 2D surveys, 2,500 blocks of 3D surveys, 900 line km of 3D WAZ and FAZ coil surveys, 1,280 line km of VSP surveys, and 175,465 line km of HRG surveys (**Table A-11**). All of these surveys are within the oil and gas exploration program, as airguns are not expected to be used for HRG surveys in either renewable energy or marine minerals programs. The renewable energy scenario includes the possibility that a deep penetration (2D or 3D) seismic survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic airgun survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

The proposed action also includes HRG surveys for renewable energy and marine minerals programs, as described in **Sections 2.2.3** and **2.2.4**; activity levels for the 2012-2020 time period are provided in **Tables A-5** and **A-6**. These surveys are expected to use only electromechanical sound sources (e.g., boomer and chirp subbottom profilers, side-scan sonars, and multibeam depth sounders). As discussed below, the electromechanical sources are not likely to be audible to sea turtles, except for the boomer at close range.

Effects of Seismic Airgun Surveys

Based on the scope of the proposed action, seismic airgun surveys could affect individuals from all sea turtle species within the BA Area, potentially including hawksbill turtles within the southernmost part of the region. Subadult and adult turtles may be more likely to be affected by seismic airgun noise than post-hatchling turtles because of the time that the former remain submerged and at depth. Post-hatchling turtles generally reside at or near the sea surface and may be less likely to be injured by the sound field produced by an airgun array. It is anticipated that seismic airgun surveys conducted in shallower parts of the BA Area may affect a greater number of individual turtles, particularly species other than leatherbacks. Deepwater surveys are likely to affect fewer individual turtles but are more likely to affect leatherback turtles, particularly within areas of upwelling where individuals may be found in feeding aggregations. Also, surveys conducted during summer sea turtle nesting periods may affect greater numbers of adult turtles, particularly loggerhead, green, and leatherback turtles, than surveys conducted during non-nesting periods.

Section 7 discusses the operational mitigation measures that would be implemented during seismic airgun surveys, including ramp-up of airgun arrays, visual monitoring of an exclusion zone by protected species observers, and startup and shutdown requirements. The purpose of these operational measures is to prevent injury to sea turtles by ensuring that they are not present within an exclusion zone around the airgun array. If the operational mitigation measures were 100 percent successful, then most auditory impacts on sea turtles would be avoided. The BOEM expects that mitigation measures would not be 100 percent effective, and therefore there is the potential to expose some sea turtles to sound levels that could cause TTS or PTS. However, no deaths or life-threatening injuries are expected.

Detection of sea turtles by visual monitoring during seismic airgun surveys can be difficult. Sea turtles spend most of their life below the sea surface. Individuals on the sea surface, particularly subadults and juveniles, are generally not demonstrative and may be difficult to detect during visual surveys, particularly during periods of elevated sea states or low visibility. Most post-hatchling sea turtle species tend to aggregate in mats of floating *Sargassum* within or near zones of ocean current convergence, though it is unlikely that a visual observer would detect their presence during visual mitigation monitoring surveys. Species such as green turtles and leatherback turtles tend to avoid *Sargassum* mats and may be even more difficult to detect during these mitigation surveys.

It is possible that sea turtles would move away from approaching and/or increasing levels of sound during the ramp-up period of a seismic survey. However, a sea turtle's response could also include diving below the airgun array, which would increase the likelihood of auditory impacts.

The operational mitigation measures during seismic airgun surveys would not prevent behavioral disturbance to sea turtles at distances beyond the exclusion zone. As noted previously, avoidance responses to seismic signals have been observed in sea turtles at received SPLs between 166 and 179 dB re 1 µPa (Moein et al., 1995; McCauley et al., 2000). Received SPLs of 160 dB re 1 µPa could extend up to 15 km (9.3 mi) from a large airgun array (5,400 in.^{3}) and up to 3 km (1.9 mi) from a small airgun array (90 in.^{3}), depending on the geographic location and season modeled.

Air gun surveys are likely to adversely affect listed sea turtle species. The most likely impacts on sea turtles are expected to be short-term behavioral responses of individuals in proximity to airgun arrays. In cases where individual sea turtles cannot or do not avoid airgun arrays and are not detected by visual observers, TTS or PTS could occur, but no deaths or life-threatening injuries are expected.

Effects of Non-Airgun HRG Surveys

The HRG surveys of renewable energy and marine minerals sites would use only electromechanical sources such as side-scan sonar, boomer and chirp subbottom profilers, and multibeam depth sounders. Based on their operating frequencies as summarized in **Table A-14**, the side-scan sonar, chirp subbottom profiler, and multibeam depth sounder are not likely to be detectable by sea turtles, whose best hearing is mainly below 1,000 Hz. The boomer has an operating frequency range of 200 Hz–16 kHz, and so may be audible to sea turtles. However, it has a very short pulse length (120, 150, or 180 µs) and a very low source level, with a 180-dB radius ranging from 38-45 m (125-148 ft) (or less than 5 m [16 ft] if pulse duration is taken into account) (**Table A-15**). Therefore, sea turtles are unlikely to hear any of the electromechanical sources except perhaps the boomer at very close range. Because the proposed action includes a recommended separation distance of 45 m (150 ft) from sea turtles for vessel strike avoidance (see **Section 7.1.4**), auditory or behavioral impacts due to electromechanical sources are unlikely. Therefore, the use of non-airgun HRG surveys is not expected to affect listed sea turtle species.

Effects on Turtle Nesting

Seismic airgun surveys conducted off of heavily used nesting beaches during the nesting season could temporarily displace adult turtles that are approaching or departing nesting beaches or resting in offshore waters between nesting events. Beaches of southeast Florida have been identified as the most important nesting area for loggerhead turtles (part of the Penisular Florida Recovery Unit) in the western hemisphere (USDOC, NMFS and USDOI, FWS, 2008). The northern segment of the Archie Carr NWR borders the BA Area, and it has been estimated that 25 percent of all loggerhead nesting in the U.S. occurs there (USDOI, FWS, 2011e). During the 2010 nesting season, there were over 31,000 loggerhead nests in Brevard County, where the Archie Carr NWR is located. It is likely that large numbers of sea turtles would be present in nearshore and inner shelf waters of Brevard County during the nesting season from May 1 through October 31. Many adult females linger near the nesting beaches before and between nesting events, resting under rocky ledges and outcrops in inner shelf waters for periods of weeks. Depending on various factors including (1) the distance of the survey from shore; (2) local factors such as seafloor topography and seafloor substrate that may affect the lateral propagation of underwater sound; and (3) the duration and intensity of survey effort in this area, it is likely that in these cases breeding adults, nesting adult females, and hatchlings could be exposed to airgun seismic survey-related sound exposures at levels of 180 dB re 1 µPa or greater. Potential impacts could include auditory injuries to adults and dispersion of hatchlings, though the latter may be somewhat insulated from the highest sound levels because of their occurrence at or near the sea surface.

Multiple Exposures to Airgun Pulses

Sea turtles could be exposed to multiple airgun pulses within a given survey, from different surveys within a year, and in different years over the 2012-2020 time period. Although sea turtles were not included in the incidental take modeling, based on an examination of the raw data from the marine mammal analysis, it is expected that only a relatively small percentage of animals would be affected more than once by pulses emitted along different legs (lines) of a particular survey. Because the proposed action includes surveys over a period of several years (2012-2020), it is also possible that some of the same animals could be affected during more than one year.

Conclusions

Listed sea turtles may be adversely affected by seismic air gun surveys. Effects could include direct auditory impacts (including TTS or PTS) and behavioral disturbance of sea turtles. Because of the operational mitigation measures that would be implemented during seismic airgun surveys and non-airgun HRG surveys, the risk of auditory impacts is expected to be avoided to the maximum extent practicable; however, the actual mitigation effectiveness and reduction of incidental takes have not been estimated. See **Section 7.1.2.6** for a brief discussion of mitigation effectiveness.

Some acoustic impacts on sea turtles are expected to be avoided by the time-area closure for North Atlantic right whales that is included in the proposed action because the closure would preclude airgun surveys in some near-coastal waters during certain months.

5.2.3. Effects on Birds

Piping plovers and red knots inhabit beaches and flats along the coast and are not likely to come into contact with active acoustic sound sources from G&G surveys. The Bermuda petrel and roseate tern occur offshore but do not spend substantial time under water, and therefore they are unlikely to be affected by active acoustic sound sources.

Roseate terns forage mainly by plunge-diving and surface dipping, and Bermuda petrels feed by snatching food or "dipping," or by scavenging dead or dying prey floating on or near the sea surface. Active acoustic sound sources used for G&G surveys are intermittent (e.g., airguns firing at 10-15 s intervals) and highly directive (e.g., downward, toward the seafloor). Because of these source characteristics and the brief time that plunge-diving birds spend underwater with each dive, there is little risk of impacts. It is expected that few if any roseate terns or Bermuda petrels would be exposed to active acoustic sound sources other than on an occasional basis.

Seabirds have air-adapted ears and are not believed to be particularly sensitive to underwater sound (Dooling and Popper, 2000; Dooling, 2002). There is no evidence that birds use underwater sound. Consequently, there is very little potential for active acoustic sound sources to directly affect these birds even if they were briefly exposed to underwater noise.

Investigations into the effects of airguns on seabirds are extremely limited. Stemp (1985) and Lacroix et al. (2003) did not observe any mortality to the several species of seabirds studied when exposed to seismic survey noise; further, they did not observe any differences in distribution or abundance of those same species as a result of seismic survey activity. Based on the directionality of the sound generated from seismic airgun surveys and low frequency equipment used for HRG surveys and the limited study results available, it is expected that there would be no mortality or life-threatening injury and little disruption of behavioral patterns or other non-injurious effects for any of the listed bird species.

Short-term, indirect effects on foraging could occur as a result of behavioral responses of prey species (e.g., fishes) in the immediate vicinity of seismic survey operations. However, any effects would be localized (near survey vessels) and transient. With the seismic source vessel moving at speeds of about 4.5 kn (8.3 km/hr), the vessel and its streamers would pass any given point within about an hour. If prey species avoided an area in which a survey was being performed, it would represent a very small portion of a bird's foraging range. Any indirect impacts on prey behavior would not be expected to adversely affect either the roseate tern or Bermuda petrel.

5.2.4. Effects on Fishes

The range of potential effects due to noise, in order of decreasing severity, is (1) death, (2) physiological effects, (3) hearing threshold shift, (4) masking, and (5) behavioral response. In estimating the potential effects of noise to fishes, it is important to understand that any sound source produces both pressure waves and actual motion of the medium particles. All fishes, including elasmobranchs such as the listed smalltooth sawfish, detect particle motion since it directly stimulates the inner ear (Popper et al., 2003). Bony fishes with an air bubble (most often the swim bladder) are also likely to detect pressure signals that are re-radiated to the inner ear as particle motion. Species detecting pressure hear a wider range of frequencies and sounds of lower intensity than fishes without an air bubble (such as the listed shortnose sturgeon and Atlantic sturgeon) since the bubble re-radiates the received signal, which is then detectable by the ear as a secondary sound source (Popper et al., 2003; Popper and Fay, 2010).

Hearing thresholds have been determined for perhaps 100 fish species; data on hearing thresholds can be found in Fay (1988), Popper et al. (2003), Ladich and Popper (2004), Nedwell et al. (2004), Ramcharitar et al. (2006), and Popper and Schilt (2008). These data demonstrate that, with few exceptions, fishes cannot hear sounds above about 3-4 kHz, and the majority of species are only able to detect sounds to 1 kHz or below. Studies of the family Aceripensidae (sturgeons) suggested that the highest frequency they can detect is 800 Hz and that they have relatively poor sensitivity (Lovell et al., 2005; Meyer et al., 2010). There have also been studies on a few species of cartilaginous fishes such as the smalltooth sawfish, with results suggesting that they detect sounds to no more than 1,000 Hz and are not very sensitive to sound (Casper et al., 2003).

BOEM recently conducted a workshop on the effects of industry-produced noise on fish and invertebrates. The worshop effort also included a literature review of what is known regarding the potential for effects. This review can be found on-line at: http://www.boemsoundworkshop.com/documents/Literature_Synthesis_Effects_of_Noise_on_Fish_Fisheries_and_Invertebrates.pdf.

5.2.4.1. Death

Active acoustic sound sources included in the proposed action, including airguns, are not expected to kill any ESA-listed fish species. The only data on mortality associated with sound sources other than explosives comes from studies of driving very large piles. For example, the California Department of Transportation (Caltrans, 2001) showed some mortality for several different species of wild fishes exposed to driving of steel pipe piles 2.4 m (8 ft) in diameter. However, mortality does not seem to occur at distances of more than approximately 10 m (33 ft) from the source. Since the proposed action will not use explosives or include pile driving, immediate mortality is not a potential effect. The potential for delayed mortality due to physiological impacts is discussed below.

5.2.4.2. Physiological Effects

Non-auditory physiological effects from exposure to intense sounds generally result from rapid and substantial expansion and contraction of the air bubble walls within fishes (such as the swim bladder or air bubbles in the blood) that strike against nearby tissues or from air bubbles within the blood bursting or expanding and damaging tissues (Stephenson et al., 2010). The actual nature of non-auditory physiological effects may range from a very small amount of external bleeding to small internal bleeding to substantial hemorrhage of tissues (such as kidney or liver) to rupture of the swim bladder (see Stephenson et al. [2010] and Halvorsen et al. [2011a,b] for a discussion of the range of potential effects).

There are several potential (and overlapping) consequences of non-auditory physiological effects (Stephenson et al., 2010; Halvorsen et al., 2011a,b). One possibility is that the effects heal, and there is no lasting consequence. Alternatively, even if the physiological effect has no direct consequences per se, it is possible that it leads to temporary decreased fitness of the animal until the damage is healed. This could result in the animal being subject to predation, less able to find food, or other consequences that result in death. Secondly, the effect could result in delayed mortality from events such as continuous bleeding or disruption of tissues (e.g., spleen or liver); or, the tissue damage itself may not be life threatening, but it may become infected and potentially result in death.

There are few quantified and reliable data on effects of exposure to high-intensity sound on body tissues. There are a number of studies showing no tissue damage as a result of exposure of several different species to sonar (Kane et al., 2010), seismic devices (Song et al., 2008), and pile driving (Caltrans, 2010a,b). However, in each of these studies, the swim bladder in the fishes may not have been filled with air, and this could have resulted in less likelihood of damage as compared to situations where the swim bladder is filled to its normal density of air (Halvorsen et al., 2011a,b).

The only quantifiable study documenting a range of physiological effects on fishes comes from exposure of Chinook salmon to 960 or 1,920 strikes of simulated pile driving sounds (Casper et al., 2011; Halvorsen et al., 2011a,b). This study demonstrates that effects are graded, with what is likely to be minimal peripheral bleeding at the lowest (but still very intense) sound exposures (210 dB re 1 $\mu Pa^2 \cdot s$

SEL) to significant bleeding and tissue rupture at the very highest levels presented in the study (219 dB re 1 $\mu Pa^2 \cdot s$ SEL). Importantly, fish held for a period of time post-exposure showed complete recovery from most of the effects, although the investigators are very careful to point out that recovery took place in a laboratory tank where fish with slightly lowered fitness would not be subject to predation or disease, as may happen in the wild (Casper et al., 2011).

Several studies have examined effects of high-intensity sounds on the ear. While there was no effect on ear tissue in either the Navy Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar study (Popper et al., 2007) or in the study of effects of seismic airguns on hearing (Popper et al., 2005; Song et al., 2008), three earlier studies suggested that there may be some loss of sensory hair cells resulting from exposure to high-intensity sources. However, none of these studies concurrently investigated effects on hearing. Enger (1981) showed some loss of sensory cells in Atlantic cod after exposure to pure tones. A similar result was shown for the lagena of the oscar, a cichlid fish, after an hour of continuous exposure (Hastings et al., 1996). In neither study was the hair cell loss more than a relatively small percentage of the total sensory hair cells in the hearing organs. Most recently, McCauley et al. (2003) showed loss of a small percentage of sensory hair cells in the saccule (the only end organ studied) of the pink snapper, and this loss continued to increase (but never to become a major proportion of sensory cells) for up to at least 53 days post-exposure. However, based on the considerable data demonstrating hair cell replacement and addition in many fish species, it is likely that the high rate of sensory cell proliferation in fishes would have compensated for the small number of lost hair cells (e.g., Corwin, 1981; Popper and Hoxter, 1984; Lombarte and Popper, 1994, 2004).

5.2.4.3. Hearing Threshold Shift

Although PTS can result from exposure to very loud sounds in humans and other mammals, PTS is not known to occur in fishes, since unlike mammals, they can repair and regenerate the sensory cells of the ear that are damaged (e.g., Lombarte et al., 1993; Smith et al., 2006). The data suggest that TTS occurs after long-term exposure to sounds that are as high as 170-180 dB re 1 µPa, but only in species that have specializations that result in their having relatively wide hearing bandwidths (to over 2 kHz) and lower hearing thresholds than fishes without specializations. Based on the available data, the fish species included in the BA are unlikely to experience hearing threshold shift from the proposed action.

5.2.4.4. Masking

Similar to masking in marine mammals, noise can affect hearing and partially or completely reduce an individual’s ability to effectively communicate, detect important predator, prey, and/or conspecific signals, and/or detect important environmental features associated with spatial orientation (see Clark et al., 2009 for a review). Spectral, temporal, and spatial overlap between the masking noise and the sender/receiver determine the extent of interference; the greater the spectral and temporal overlap, the greater the potential for masking. Thus, if a fish uses sounds to detect predators, the presence of the increased ambient sound would keep the fish from hearing the predator until it was much closer. Similarly, if male fishes use sounds to attract females, as occurs in toadfish (reviewed in Zelick et al., 1999), sciaenids (reviewed in Ramcharitar et al., 2006), and many other species, the female would have to be much closer to the males before they could hear the sound.

The sound energy of the proposed sources is primarily directed towards the seafloor, but reflected energy does propagate horizontally away from the sources and can result in masking. In addition, vessel noise is primarily low-frequency and will contribute to the ambient noise level of the surrounding environment. Smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon likely use sound to detect predators and prey and obtain an understanding of the acoustic scene.

5.2.4.5. Behavioral Response

Perhaps the most likely effects of active acoustic sound sources would be behavioral responses. The available data show, in general, that as sound levels in the environment increase, animals tend to respond in different ways, which often vary depending on the nature of the sound source and sound level as well as on the behavioral state of the animal (e.g., what it is doing) when the sound level changes. Responses of animals vary widely (reviewed in Brumm and Slabbekoorn [2005]). These may include movement from the area of maximum sound level, as shown for several fish species (Engås et al., 1996; Slotte et al., 2004), to changing the intensity of calls so they can be heard over the background sounds (Bee and Swanson, 2007) or changing the spectrum of the emitted sounds so they are no longer masked, as has been shown in a variety of species (Brumm and Slabbekoorn, 2005; Dooling et al., 2009; Parris et al., 2009; Laiolo, 2010; Slabbekoorn et al., 2010).

A study by Jorgenson and Gyselman (2009) may provide some insight into how fishes would behave in response to intense anthropogenic sounds. The authors exposed fishes in the Mackenzie River (Northwest Territories, Canada) to seismic airguns and, using sonar, observed the movements of the fishes. The goal was to determine if a seismic survey using high-intensity sounds for long periods of time could impact behavior by changing migratory patterns of fishes. The investigators could not determine the species observed by sonar, but based on known river inhabitants, they suggest that there were a variety of species present, including those used by Popper et al. (2005). While results may be limited to one or two species, the investigators found that free-swimming fishes observed with sonar showed no response to the airguns with respect to changes in swimming direction or speed, even when sound exposure levels (single discharge) were on the order of 175 dB re 1 $\mu Pa^2 \cdot s$ and peak levels of over 200 dB re 1 µPa.

5.2.4.6. Analysis of the Proposed Action Scenario

The proposed action includes extensive seismic surveys (i.e., using airguns) during the 2012-2020 time period. These include 617,775 line km of 2D surveys, 2,500 blocks of 3D surveys, 900 line km of 3D WAZ and FAZ coil surveys, 1,280 line km of VSP surveys, and 175,465 line km of HRG surveys (**Table A-11**). All of these surveys are within the oil and gas exploration program, as airguns are not expected to be used for HRG surveys in either renewable energy or marine minerals programs. The renewable energy scenario includes the possibility that a deep penetration (2D or 3D) seismic survey would be conducted to evaluate formation suitability for carbon sequestration. However, a single seismic airgun survey for carbon sequestration is not analyzed separately. It is assumed that such a survey would be similar in scope to a single 2D or 3D seismic airgun survey for oil and gas exploration. Because of the large number and extent of seismic airgun surveys included in the oil and gas scenario and the likelihood that some of those surveys may not be conducted due to overlapping coverage, a single survey for carbon sequestration would not change the effects at a programmatic level.

Effects on Smalltooth Sawfish

Because no specific information is available on hearing range in smalltooth sawfish, inferences must be made by examing available data on other elasmobranchs (sharks and rays). From this perspective, the smalltooth sawfish likely hears sounds within a very low frequency range (600 or 800 Hz) and relies on water particle motion to sense these sounds (Myrberg et al., 1976; Myrberg, 2001; Casper et al., 2003; Casper and Mann, 2006). Therefore, sounds from airguns (10-2,000 Hz) projected for the proposed action fall within the audible range of the smalltooth sawfish. With the exception of the boomer subbottom profiler (0.2-16 kHz), sounds from the electromechanical equipment fall within a much higher frequency range (3.5-400 kHz) than the airguns (**Table A-14**) and outside of the smalltooth sawfish's hearing range. Airgun noise would be of primary concern where it affects behavior of individuals, particularly those involved in reproduction or foraging. Smalltooth sawfish are currently absent from areas north of North Carolina (Mid-Atlantic Planning Area) and rare between Cape Canaveral, Florida, and Cape Hatteras, North Carolina (South Atlantic Planning Area). Surveys of sand borrow areas or renewable energy sites conducted in inner shelf or coastal waters would be the most likely G&G activities to encounter smalltooth sawfish.

Based on the preceding discussion, airgun pulses are not expected to result in death or injury of any smalltooth sawfishes. Since smalltooth sawfishes do not have any specializations that increase their hearing sensitivity, it is unlikely they would experience any hearing threshold shift from the proposed action. The most likely effects, if any, would be transient behavioral responses. Because of the rare occurrence of the smalltooth sawfish within the BA Area, active acoustic sound sources under this Proposed Action may affect but are not likely to adversely affect smalltooth sawfish.

Effects on Shortnose Sturgeon

Although little is known about hearing in shortnose sturgeon, studies on other sturgeon species indicate hearing at very low frequencies (<800 Hz) (see **Appendix J** of the Programmatic EIS). Interestingly, some sturgeon species apparently produce sounds prior to reproduction that can be higher (2 kHz) than their detectable hearing range (Johnston and Phillips, 2003). From this information it can be assumed that shortnose sturgeon hearing is probably in the range of frequencies generated by airguns and boomers. The severity of impacts caused by the airgun sounds would depend on the intensity and distance from the source. For the proposed action, the most likely effects of active acoustic sound sources on shortnose sturgeon would be temporary hearing loss, masking, and behavioral changes. The fact that shortnose sturgeon reside primarily within estuaries and rivers outside of the BA Area suggests that any effects would be very limited in space and over time. Some portion of the shortnose sturgeon population enters into the coastal ocean, but interactions with G&G surveys would be rare because coastal waters represent a small fraction of the BA Area. Therefore, active acoustic sound sources under this Proposed Action may affect but are not likely to adversely affect shortnose sturgeon.

Effects on Atlantic Sturgeon

As described above for the shortnose sturgeon, Atlantic sturgeon likely has underwater hearing sensitivity that is limited to less than 800 Hz, suggesting that this species could detect low-frequency sound sources. Airguns and boomers produce sounds in low frequency ranges that overlap with the presumed hearing range of Atlantic sturgeon. Unlike the smalltooth sawfish and shortnose sturgeon, the Atlantic sturgeon occurs widely over the shelf of the BA Area. Concentrations of this species occur offshore of North Carolina and Virginia in the Mid-Atlantic Planning Area and South Carolina in the South Atlantic Planning Area. Since they do not have any specializations that increase their hearing sensitivity, it is unlikely they would experience any hearing threshold shift from the proposed action. The most likely effects, if any, would be transient behavioral responses. Seismic airgun surveys could temporarily disrupt or displace Atlantic sturgeons in areas of known concentrations. However, certain mitigation measures (e.g., time/area closures, establishment of exclusion zones, ramp up procedures) although designed for marine mammals would also indirectly provide protective benefits to Atlantic sturgeon. Any anticipated behavioral responses at any given location would be transient. Therefore, active acoustic sound sources under this Proposed Action may adversely affect the Atlantic sturgeon population.

Effects on Blueback Herring

The blueback herring and its close relatives have specialized hearing anatomy enabling them to detect very high frequency (25-135 kHz) sounds. Studies on the American shad revealed a specialized hearing anatomy for this species and members of the clupeid subfamily Alosinae, the latter of which includes blueback herring (Mann et al., 1997; Popper et al., 2004). Unlike most fishes, the members of this subfamily can hear sounds in the ultrasonic range (>120 kHz). It is thought that the ability to perceive such high frequency sounds evolved as a means of sensing the presence of echolocating predators such as bottlenose dolphin, which are primary predators of these fish in the coastal oceans (Popper et al., 2004). Experimental tests conducted with blueback herring in the Savannah River (Georgia-South Carolina border) confirmed avoidance responses to high frequency sound (Nestler et al., 1992). Results also determined a maximum avoidance response to sounds ranging from 124.6-130.9 kHz at 187-200 dB re 1 μPa emitted by a single electromechanical transducer positioned 180 ft (60 m) from the fish. Comparative trials using lower frequency sounds resulted in limited or no response from test subjects (Nestler et al., 1992). These results and others on the related alewife (see below) suggest that blueback herrings may avoid G&G survey vessels that are using airguns and/or electromechanical sources. No masking or temporary hearing loss would be expected. Behavioral responses at any given location would be transient so active acoustic sound sources under this Proposed Action may affect but are not likely to adversely affect the blueback herring population.

Effects on Alewife

As described previously for blueback herring, the alewife can also hear high-frequency sounds (Dunning et al., 1992). Responses of alewives to sounds emitted from electromechanical transducers were tested in Lake Ontario. Ross et al. (1996) found that sounds ranging from 122-128 kHz at a maximum intensity of 190 dB re 1 μPa were effective in deterring alewife schools from entering water intakes of a power plant. This suggests that alewives, like blueback herring, may avoid G&G survey vessels using airguns and/or electromechanical sources. No masking or temporary hearing loss is expected. Behavioral responses at any given location would be transient so active acoustic sound sources under this Proposed Action may affect but are not likely to adversely affect the alewife population.

5.3. VESSEL AND EQUIPMENT NOISE

Most of the G&G activities in the proposed action scenario would be conducted from ships. The most extensive vessel activities are 2D and 3D seismic airgun surveys, which could occur anywhere in the BA Area. Vessels conducting G&G surveys or sampling for renewable energy would be operating mainly at specific sites (consisting of one or more OCS blocks) in water depths less than 100 m (328 ft) and along potential cable routes. Vessels conducting G&G surveys or sampling for marine minerals would be operating mainly at specific borrow sites in water depths less than 30 m (100 ft).

Vessel noise is one of the main contributors to overall noise in the sea (NRC, 2003; Jasny et al., 2005). The G&G survey vessels would contribute to the overall noise environment by transmitting noise through both air and water. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Broadband source levels for most small ships (a category that would include seismic survey vessels and support vessels for drilling of COST wells or shallow test wells) are anticipated to be in the range of 170-180 dB re 1 μPa at 1 m (Richardson et al., 1995). Broadband source levels for smaller boats (a category that would include survey vessels for renewable energy and marine minerals sites) are in the range of 150-170 dB re 1 μPa at 1 m (Richardson et al., 1995). Noise levels would dissipate quickly with distance from the source.

Drilling of COST and shallow test wells would introduce additional underwater noise into the BA Area from engines, generators, and other drilling rig equipment. The oil and gas scenario assumes that up to three COST wells and up to five shallow test wells would be drilled in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. Neither the well locations nor the types of drilling rig are known at this programmatic stage. Jack-up rigs typically are used in water depths less than 100 m (328 ft) (USDOI, MMS, 2007b). Semisubmersibles are floating rigs that are used in depths ranging from 100-3,000 m (328-9,843 ft) and can be either moored or dynamically positioned. Drillships are used in water depths greater than about 600 m (1,968 ft) and can also be moored or dynamically positioned (usually the latter).

Drilling of deep stratigraphic and shallow test wells is typically an off-lease activity, especially in frontier areas, or can be carried out on a leased block if it does not interfere with the leaseholder's activities. These activities may occur infrequently in the BA Area during the time period of the Programmatic EIS. As defined by 30 CFR 551.1, a deep stratigraphic test well must penetrate at least 152 m (500 ft) into the seafloor; otherwise, it is classified as shallow test drilling.

Continental Offshore Stratigraphic Test (COST) wells typically are drilled to obtain information about regional stratigraphy, reservoir beds, and hydrocarbon potential. These wells are drilled away from any potential petroleum-bearing feature to minimize the chance of encountering oil or gas. The data are used to evaluate structural interpretations from geophysical surveys, determine the age of sediments drilled, and estimate the potential for hydrocarbon accumulation and for determining the presence, absence, or quality of gas hydrate deposits. Drilling would be done by conventional, rotary drilling equipment from a drilling rig; the selection of a moored versus dynamically positioned drilling rig would depend on water depth, site-specific seafloor conditions, and rig availability. Shallow test wells are drilled post-lease to allow operators to place wireline testing equipment into a borehole to evaluate subsurface properties such as the presence of gas hydrates. Drilling would be done by conventional, rotary drilling equipment from a drilling barge or boat. It is likely that at least in the South Atlantic Planning Area, in the Blake Plateau region, there will be some interest in a test program for gas hydrates within the proposed action scenario period. These wells could be considered either COST wells or shallow test drilling, depending on the penetration depth.

Noise from drilling operations includes strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies in at least some cases (Richardson et al., 1995). Machinery noise can be continuous or intermittent, and variable in intensity. Noise levels vary with the type of drilling rig and the water depth. Drillships produce the highest levels of underwater noise because the hull containing the rig generators and drilling machinery is well coupled to the water. In addition, dynamically positioned drillships use thrusters to maintain position and are constantly emitting engine and propeller noise. Jack-up rigs are at the other end of the spectrum because they are supported by metal legs with only a small surface area in contact with the water, the drilling machinery is located on decks well above the water, and there is no propulsion noise. Semisubmersibles are intermediate in noise level because the machinery is located well above the water but the pontoons supporting the structure have a large surface area in contact with the water. Richardson et al. (1995) noted that broadband source levels for semisubmersible rigs have been reported to be about 154 dB re 1 µPa. Source levels for drillships have been reported to be as high as 191 re 1 µPa during drilling.

Drilling operations would be supported by crew boats, supply vessels, and helicopters traveling between the drilling rig and the onshore support base. Support vessels usually make a few round trips per week, and helicopters typically make one round-trip daily. The characteristics of vessel noise have been described in **Section 5.2**, and aircraft noise is discussed in **Section 5.5**.

5.3.1. Effects on Marine Mammals

The G&G activities in all three program areas would generate vessel and equipment noise that could disturb marine mammals. The types of sound produced by these sources are nonpulsed, or continuous. The current acoustic harassment threshold established by NMFS for continuous sounds is 120 dB re 1 µPa. This threshold was based on avoidance responses observed in whales, specifically from research on migrating gray whales and bowhead whales (Malme et al., 1983, 1984, 1988; Richardson et al., 1986, 1990; Dahlheim and Ljunblad, 1990; Richardson and Malme, 1993). Actual responses of individuals could vary widely and are heavily dependent on context (Richardson et al., 1995; Southall et al. 2007; Ellison et al., 2011).

The effects of noise produced by moving G&G survey vessels on marine mammals are difficult to assess because of the wide array of reports of their observed behavioral responses, both between and among species. Several species of small toothed cetaceans have been observed to avoid boats when they are approached to within 0.5-1.5 km (0.3-0.9 mi), with occasional reports of avoidance at greater distances (Richardson et al., 1995). Reports of responses of cetacean species to moving power vessels are variable, both between species and temporally (Richardson et al., 1995). It is conservative to assume that vessel noise may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel. For most of the time that seismic survey vessels are underway, they would be operating their airguns or other active acoustic sound sources; under these conditions, Level B take numbers have already been accounted for. During those periods when non-seismic vessels are operating, or when seismic vessels have shut down their airguns, the potential for behavioral impacts from vessel and equipment noise remains.

Under the proposed action, all authorizations for shipboard surveys would include guidance for maintaining safe distances between G&G vessels and protected species to minimize potential impacts from vessel and equipment noise and the avoidance of vessel collisions with these protected species. The guidance would be similar to Joint BOEM-BSEE NTL 2012-G01 (*Vessel Strike Avoidance and Injured/Dead Protected Species Reporting*), which incorporates NMFS "Vessel Strike Avoidance Measures and Reporting for Mariners" addressing protected species identification, vessel strike avoidance, and injured/dead protected species reporting (USDOI, BOEM and BSEE, 2012b). For the proposed activities, it is assumed that this guidance would avoid or minimize potential negative impacts to marine mammals from both the presence of vessels and the noise they produce.

The proposed action also includes a time-area closure in which no G&G surveys using airguns would be authorized in the right whale critical habitat from November 15 through April 15, nor in the Mid-Atlantic and Southeast SMAs for the North Atlantic right whale during the times when vessel speed restrictions are in effect under the Right Whale Ship Strike Reduction Rule (50 CFR 224.105). In addition, HRG surveys proposed in these areas would be considered on a case-by-case basis only if they use acoustic sources other than airguns. These measures are expected to reduce vessel-related noise impacts to this species during its seasonal migration and calving/nursing periods. In addition, other species found in these areas during closures would also benefit from this protective measure. Based on the proposed volume of vessel traffic associated with project activities, the presumption that marine mammals within the BA Area are familiar with various and common vessel-related noises, and the implementation of protective measures (e.g., time/area closures, Joint BOEM-BSEE NTL 2012-G0), project-related vessel and equipment noise within the BA Area is expected to affect but not adversely affect ESA-listed marine mammals.

Other sound sources associated with the proposed activity include drilling-related noises during the completion of up to three COST wells and up to five shallow test wells in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. It is expected that marine mammals would detect drilling-related noises; the range of audibility would vary depending on the sound source level and local attenuation from factors such as water depth, seafloor characteristics, and sea state conditions. It is expected that drilling noise may elicit behavioral responses such as changes in swimming direction or speed. However, studies indicate that the sensitivity of marine mammals to drilling noise varies between and within species (Richardson et al., 1990).

There are few drilling operations associated with the proposed activity (up to three COST wells and up to five shallow test wells). Under the time-area closure included in the proposed action, drilling operations would not be authorized within within the Mid-Atlantic and Southeast U.S. SMAs for the North Atlantic right whale during the times when vessel speed restrictions are in effect under 50 CFR 224.105, unless an operationserves important operational or monitoring requirements in conflict with the time-area closure. With these measures in place, most impacts on North Atlantic right whales (the baleen whale species most likely to regularly occur within inner shelf waters of the BA Area) are expected to be avoided by the time-area closure. Although North Atlantic right whales could occur anywhere within the BA Area, they are most likely to be found in the calving/nursery areas during the winter months and/or near the coast along their migratory corridor (Knowlton et al., 2002). Considering the low number of drilling operations and the continuous nature of sounds produced, drilling operations under this Proposed Action may affect but are not likely to adversely affect listed marine mammals.

5.3.2. Effects on Sea Turtles

The most likely effects of vessel and equipment noise on sea turtles would include behavioral changes and possibly auditory masking. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel, and the source levels are too low to cause death or injuries such as auditory threshold shifts. Based on existing studies on the role of hearing in sea turtle ecology, it is unclear whether masking would realistically have any effect on sea turtles (Mrosovsky, 1972; Samuel et al., 2005; Nunny et al., 2008). Behavioral responses to vessels have been observed but are difficult to attribute exclusively to noise rather than to visual or other cues. It is conservative to assume that noise associated with survey vessels may elicit behavioral changes in individual sea turtles near vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. This evasive behavior is not expected to adversely affect these individuals or the population, and impacts are not expected to be significant.

Drilling-related noises during the completion of COST wells and shallow test wells may be audible to sea turtles; the range of audibility would vary depending on the sound source level and local attenuation from factors such as water depth, seafloor characteristics, and sea state conditions. Drilling-related noise is continuous, and it is expected that the sound source may elicit behavioral responses in sea turtles that may include temporary avoidance or displacement of sea turtles from a small radius around the drilling area. Studies of sea turtles in the proximity of platforms are not conclusive on whether the turtles may habituate to the continuous sound source. Considering the low number of drilling operations, the continuous nature of sounds produced during drilling operations and the frequency levels of these sounds, drilling operations under this Proposed Action may affect but are not likely to adversely affect listed sea turtles.

5.3.3. Effects on Birds

Most G&G survey activities included in the proposed action would be performed from vessels, which have the potential to disturb marine and coastal birds (Schwemmer et al., 2011). However, the piping plover and red knot are shorebirds that are unlikely to be affected by G&G survey vessels transiting from port to offshore or coastal locations. The roseate tern and Bermuda petrel are seabirds that are more likely to come into contact with G&G vessel traffic and noise.

The sound generated from individual vessels can contribute to overall ambient noise levels in the marine environment on variable spatial scales. As stated above, birds have a relatively restricted hearing range, from a few hundred hertz to about 10 kHz (Dooling and Popper, 2000) for airborne noise, with few data available regarding bird hearing range for underwater noise. Vessel noise is one of the main contributors to overall noise in the sea (NRC, 2003; Jasny et al., 2005), and G&G survey vessels would contribute to the overall noise environment by transmitting noise through both air and water. Underwater noise produced by vessels is a combination of narrow-band (tonal) and broadband sound. Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. According to Southall (2005) and Richardson et al. (1995), vessel noise typically falls within the range of 100-200 Hz. Noise levels dissipate quickly with distance from the vessel. The underwater noise generated from the survey vessels would dissipate prior to reaching the coastline and the shore/beach habitats of shorebirds, including threatened, endangered, and candidate species present in the BA Area (i.e., piping plover, roseate tern, and red knot). Because of the dissipation of underwater noise from survey vessels prior to reaching the shore/beach habitat, it is expected that underwater noise would not affect shorebird species, including piping plover and red knot.

Some seabirds such as the Bermuda petrel dive below the sea surface while foraging. However, because of the short duration of individual dives, seabirds would not be likely to be exposed to underwater noise to any significant degree.

There is the potential for impact to marine and coastal birds from the potential disturbance of breeding colonies by airborne noise from vessels and equipment (Turnpenny and Nedwell, 1994). Because the BA Area includes only Federal (OCS) waters, G&G surveys would not occur close enough to land to affect marine and coastal bird breeding colonies during survey activities. However, survey vessels for renewable energy and marine minerals projects would typically transit from a shore base to offshore and return daily. The expectation is that this daily vessel transit would occur at one of the shore bases identified or at other established ports, which have established routes for vessel traffic. Because of this existing vessel traffic, it is not anticipated that marine and coastal birds would roost in adjacent areas, or if they did already roost nearby, the addition of G&G survey vessels would not significantly increase the existing vessel traffic. In addition, noise generated from the survey vessels and equipment would typically dissipate prior to reaching the coastline and the nesting habitats of coastal birds.

The piping plover, roseate tern, and red knot are all ground nesters along the shoreline. As discussed above, these bird species would not nest in areas that would be disturbed by G&G survey vessels transiting from port to offshore or coastal locations; therefore, there would be no effect to the nesting of these shorebird species. The Bermuda petrel nests only on small, rocky offshore islets in Castle Harbor, Bermuda, and is only occasionally present in the BA Area during the non-breeding season; therefore, this species would not experience nesting impacts from G&G survey activities.

Overall, noise from vessel and drilling operations under the Proposed Action are not expected to affect listed bird species.

5.3.4. Effects on Fishes

Vessel and equipment noise are not expected to have any detectable effects on listed fish species given the limited exposure, transient and continuous sound sources, and frequency level of sound sources..

5.4. VESSEL TRAFFIC

The G&G activities in all three program areas involve vessel traffic. Vessels conducting 2D and 3D seismic airgun surveys are the largest vessels and would account for most of the line miles traveled. Based on the permit applications received by BOEM, these surveys could occur anywhere within the BA Area. Vessels conducting G&G surveys or sampling for renewable energy would be smaller and would operate mainly at specific sites (consisting of one or more OCS blocks) in water depths less than 100 m (328 ft) and along potential cable routes to shore. Similarly, vessels conducting G&G surveys or sampling for marine minerals would be operating mainly at specific borrow sites in water depths less than 30 m (98 ft). Survey vessels for renewable energy and marine minerals projects are expected to make daily round trips to their shore base, whereas the larger seismic vessels can remain offshore for weeks or months.

In the BA Area, G&G vessel traffic would be subject to the Right Whale Ship Strike Reduction Rule (50 CFR 224.105), a Federal regulation that limits vessel speed to 10 kn (18.5 km/hr) in the Mid-Atlantic and Southeast U.S. SMAs for North Atlantic right whales during migration. The Southeast U.S. SMA, with seasonal restrictions in effect from November 15 to April 15 of each year, is a continuous area that extends from St. Augustine, Florida, to Brunswick, Georgia, extending 37 km (20 nmi) from shore. The Mid-Atlantic U.S. SMA, with seasonal restrictions extending from November 1 through April 30, is a combination of both continuous areas and half circles drawn with 37-km (20-nmi) radii around the entrances to certain bays and ports. Within the BA Area, the Mid-Atlantic U.S. SMA includes a continuous zone extending between Wilmington, North Carolina, and Brunswick, Georgia, as well as the Ports of Delaware Bay (Wilmington, Philadelphia), the entrance to the Chesapeake Bay (Ports of Hampton Roads and Baltimore), and the Ports of Morehead City and Beaufort, North Carolina.

Seismic Surveys for Oil and Gas Exploration

Seismic survey vessels typically are 60-90 m (200-300 ft) long for 2D surveys and 80-90 m (262-300 ft) long for 3D surveys. The 3D surveys usually require larger vessels because there is more equipment to be towed. A typical towing speed is 4.5 kn (8.3 km/hr). These surveys could occur anywhere within the BA Area, with 24-hr operations that may continue for weeks or months, depending upon the size of the survey.

The proposed action scenario includes 617,775 line km of 2D streamer surveys, 2,500 blocks of 3D streamer surveys (or 120,000 line km, assuming 48 line km [30 line mi] per block), and 900 line km of 3D WAZ surveys. Assuming a vessel speed of 4.5 kn (8.3 km/hr), these surveys would represent about 90,000 hr (3,750 days) of vessel activity.

Seismic survey vessels are likely to remain offshore for most of the survey duration. They may be supported by supply vessels operating from ports along the Atlantic coast, but service vessel support is not a requirement. For this analysis, five potential support bases were identified: Norfolk, Virginia; Wilmington, North Carolina; Charleston, South Carolina; Savannah, Georgia; and Jacksonville, Florida. The ports were selected based on their geographic proximity to the BA Area, locations named in permit applications for G&G activities, and the availability of adequate support facilities that could be used by G&G survey and support vessels.

Renewable Energy Surveys

Vessels conducting G&G surveys or sampling for renewable energy would operate mainly at specific sites (consisting of one or more OCS blocks) in water depths less than 100 m (328 ft) and along potential cable routes to shore. Typically, the vessel would return to its shore base daily.

In nearshore waters, HRG surveys would be conducted by a single, small (<23-30 m or 75-98 ft) vessel moving at <5 kn (<9.3 km/hr). Geotechnical surveys for renewable energy sites are expected to be conducted from a small barge or ship of a similar size. A typical duration for an individual survey would be 3 days or less.

The renewable energy scenario includes 34,040 hr of HRG surveys (**Table A-5**). Assuming that HRG survey vessels would operate on 8-hr working days, the scenario would require 4,255 days and the same number of vessel round trips.

Also included in the renewable energy scenario are 3,106-9,969 geotechnical sampling locations where CPT testing, geologic coring, and grab sampling would be conducted. Assuming that one sampling location could be completed per work day, there would be approximately 3,106-9,969 vessel round trips associated with these surveys.

Vessel trips associated with renewable energy areas would use existing ports in Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida. Depending on the location of the renewable energy area, the surveys could operate from one of the five larger ports analyzed in the Programmatic EIS (Norfolk, Wilmington, Charleston, Savannah, or Jacksonville) or any of numerous smaller ports along the coast, depending on whatever is convenient.

Marine Minerals Surveys

For HRG surveys of sand source areas, geophysical survey equipment is typically deployed from a single vessel, <20-30 m (65-98 ft) long, moving at about 4.5 kn (8.3 km/hr). Surveys are likely to focus on prospective borrow sites (3-10 km^2) or reconnaissance areas (on the order of 1-3 OCS blocks), and each survey is assumed to require 1-5 operational days for completion. Vessels are assumed to operate on site for 8 hr per day and return to the shore base at the end of each day.

The marine minerals scenario includes approximately 100-3,200 km of HRG prospecting surveys, 850-4,300 km of HRG pre-lease/design surveys, and 900-4,600 km of on-lease HRG surveys (**Table A-6**). Across all geophysical survey activities, the maximum activity level is estimated at 12,100 km; this is the equivalent of approximately 1,450 hr of surveying across 180 8-hr operational survey days. The scenario would require 180 vessel round trips.

Nearly all geotechnical sampling occurs from either relatively small vessels approximately 20 m (65 ft) in length, or from work barges towed into place. A typical survey duration would be 3 days or less. The marine minerals scenario includes 6-24 deployments for pneumatic vibracoring, 1-4 deployments for geologic coring, and 2-8 deployments for grab sampling (**Table A-7**). Each deployment is assumed to involve 15-25 vibracores, 1-2 standard (geologic or rotary) cores, and 30-40 grab samples, as discussed above. Total sample numbers are estimated to include 90-600 vibracores, 1-8 geologic cores, and 60-320 grab samples. Assuming that one vibracore, one geologic core, or 25 grab samples can be collected per work day, there would be approximately 95-615 vessel round trips associated with these surveys.

Vessel trips associated with marine minerals activities would be divided among several existing ports in Delaware, Maryland, Virginia, North Carolina, South Carolina, and Florida. Georgia is excluded because the State has never had an agreement with BOEM for joint study of OCS marine minerals resources and has never requested a non-competitive lease to use them onshore. Depending on the location of the renewable energy area, the surveys could operate from one of the larger ports analyzed in the Programmatic EIS (Norfolk, Wilmington, Charleston, Savannah, or Jacksonville) or any of numerous smaller ports along the coast, depending on whatever is convenient.

5.4.1. Effects on Marine Mammals

Many marine mammal species are vulnerable to collisions with moving vessels (ship strikes) (Laist et al., 2001; Douglas et al., 2008; Pace, 2011). Most reports of collisions involve large whales, but collisions with smaller species also occur (van Waerebeek et al., 2007). Laist et al. (2001) provides records of the following vessel types associated with collisions with whales (listed in descending order): tanker/cargo vessels; whale watch vessels; passenger liners; ferries; naval vessels; recreational vessels; USCG vessels; fishing vessels; research vessels; dredges; and pilot boats. Most severe and lethal whale injuries involved large ships of lengths greater than 80 m (262 ft). Vessel speed was also found to be a significant factor, with most (89 percent) of the records involving vessels moving at 14 kn (26 km/hr) or greater. There are reports of collisions between moving vessels and most of the listed species that occur within the study area, particularly the fin whale (International Whaling Commission, 2011b). Collision with vessels is the leading human-caused source of mortality for the endangered North Atlantic right whale (USDOC, NMFS, 2005). Their slow movements, time spent at the surface, and time spent near the coast make them highly vulnerable to being struck by ships.

Marine mammal species of concern for possible ship strike with all vessels operating at speed include primarily slow-moving species (e.g., North Atlantic right whales) and deep-diving species while on the surface (e.g., sperm whales). Generally, it is assumed that the probability of this encounter, and thus impact, is very low. However, vessel operations within areas such as the North Atlantic right whale critical habitat and migration corridor during calving and nursing or migration periods may increase the probability of ship strike with this species.

Under the proposed action, all authorizations for shipboard surveys would include guidance for vessel strike avoidance similar to Joint BOEM-BSEE NTL 2012-G01 (*Vessel Strike Avoidance and Injured/Dead Protected Species Reporting*), which incorporates NMFS "Vessel Strike Avoidance Measures and Reporting for Mariners" addressing protected species identification, vessel strike avoidance, and injured/dead protected species reporting (USDOI, BOEM and BSEE, 2012b). The guidance also incorporates elements of the NMFS Compliance Guide for the Right Whale Ship Strike Reduction Rule (50 CFR 224.105), which limits vessel speed to 10 kn (18.5 km/h) in the Mid-Atlantic and Southeast U.S. SMAs for North Atlantic right whales during migration. Vessel speed restrictions in these areas are in effect between November 1 and April 30 in the Mid-Atlantic and between November 15 and April 15 in the southeast U.S.

Considering the mitigation measures that would be in place as described in **Section 7** during transits and operations**,** the slow operating speeds (for seismic vessels) and stationary nature of drilling rigs, G&G survey vessels are unlikely to strike any of the listed marine mammals. Seismic survey vessels, which account for most of the project-related vessel traffic associated with the proposed action, travel at a speed of approximately 4.5 kn (8.3 km/hr), much slower than the speeds reported to cause most of the serious or lethal injuries (Laist et al., 2001). In addition, waters surrounding survey vessels on survey would be monitored by protected species observers for the presence of marine mammals. During transit to and from shore bases, seismic vessels and other G&G survey vessels are expected to travel at greater speeds. However, as noted above, these vessel movements would be subject to BOEM guidance for vessel strike avoidance and would be required to comply with the Right Whale Ship Strike Reduction Rule. The risk of vessel strikes is also expected to be low because seismic survey vessels would be towing active acoustic sound sources that are detectable by most marine mammals (see **Section 5.2**).

Florida manatees are vulnerable to vessel collisions, with about 20 percent of documented annual mortalities in 2011 attributed to watercraft (Florida Fish and Wildlife Conservation Commission, 2012). Vessel strikes are identified as a threat in the recovery plan for this species (USDOI, FWS, 2001). However, because of their preference for shallow coastal and inland waters, it is unlikely that manatees would be present in the vicinity of G&G survey vessels operating in the BA Area. The most likely vessel traffic in near-coastal waters would be small survey vessels associated with renewable energy or marine minerals projects. Taking into account the mitigation described in **Section 7,** the slow transit and operation speeds, and the low level of manatee occurance in the BA area, vessel strikes on manatees are expected to be avoided.

5.4.2. Effects on Sea Turtles

Propeller and collision injuries to sea turtles arising from their interactions with boats and ships are common. From 1997-2005, 14.9 percent of all stranded loggerhead turtles in the U.S. Atlantic and Gulf of Mexico were documented as having sustained some type of propeller or collision injuries (USDOC, NMFS and USDOI, FWS, 2008). The incidence of propeller wounds reported in sea turtles rose from approximately 10 percent in the late 1980's to a record high of 20.5 percent in 2004. Documented propeller wounds have the highest frequency of occurrence in southeast Florida (Palm Beach through Miami-Dade Counties); during some years, as many as 60 percent of the loggerhead strandings found in these areas had propeller wounds (USDOC, NMFS and USDOI, FWS, 2008). Green turtle recovery off the U.S. west coast has been hampered by vessel collisions, especially when turtles are struck by an engaged propeller (USDOC, NMFS and USDOI, FWS, 1998a). In contrast, vessel collisions are not listed as a current threat to leatherback turtle recovery (USDOC, NMFS and USDOI, FWS, 1992, 1998b). It is likely that these reported injuries to sea turtles were largely caused by collisions with high-speed recreational powerboats because of the high volumes of these vessels operating in waters off southeast Florida and in other areas of the U.S.

There have been no documented sea turtle collisions with offshore survey and support vessels in areas such as the Gulf of Mexico, although it is possible that such collisions with small or submerged sea turtles may go undetected. Under the proposed action, all authorizations for shipboard surveys would include guidance for vessel strike avoidance. The guidance would be similar to Joint BOEM-BSEE

NTL 2012-G01 (*Vessel Strike Avoidance and Injured/Dead Protected Species Reporting*), which incorporates NMFS "Vessel Strike Avoidance Measures and Reporting for Mariners" addressing protected species identification, vessel strike avoidance, and injured/dead protected species reporting (USDOI, BOEM and BSEE, 2012b). With these mitigation measures in place, G&G survey vessels are unlikely to strike sea turtles. Seismic vessels, which account for most of the project-related vessel traffic associated with the proposed action, travel at a speed of approximately 4.5 kn (8.3 km/hr). In addition, waters surrounding survey vessels on survey would be monitored by protected species observers for the presence of sea turtles. During transit to and from shore bases, seismic vessels and other G&G survey vessels are expected to travel at greater speeds. However, these vessel movements would be subject to BOEM guidance for vessel strike avoidance and be required to reduce speed in certain areas to comply with the Right Whale Ship Strike Reduction Rule.

Sea turtles spend approximately 20 to 30 percent of their time at the surface for respiration, basking, feeding, orientation, and mating (Lutcavage et al., 1997). Because they are submerged most of the time, a collision between a project-related survey vessel and a sea turtle within the BA Area is unlikely. In addition, the risk of vessel strikes on sea turtles is expected to be minimized because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels. Any project-related vessel strike with a sea turtle could result in the death of the turtle. However, considering the relatively slow operational speed of these vessels, combined with the implementation of vessel strike avoidance measures during all surveys, vessel strikes are expected to be avoided.

5.4.3. Effects on Birds

Piping plovers and red knots are found on beaches and flats along the coast and therefore are unlikely to come into contact with G&G vessel traffic. Roseate terns and Bermuda petrels are seabirds that forage over the open ocean and could encounter moving survey vessels. Because G&G survey vessels travel slowly and spend most of their time in open ocean waters, no significant impacts on any of the listed bird species are expected.

Seabirds have three sensory abilities that are pertinent to their ability to recognize and avoid collision with vessels and other offshore structures: (1) keen eyesight; (2) good hearing; and (3) excellent tactile sensitivity. Most seabirds use vision as a key sense during foraging and other behaviors. Birds also have relatively good hearing in air, in the range of 1-5 kHz (Dooling, 2002). Seabirds also have tactile sensory abilities that enable them to sense increasing or decreasing turbulence. Most seabirds use a combination of sight, sound, and tactile sensitivity to avoid natural obstructions (e.g., rocks, islands); it is assumed that those abilities would be applied to avoid moving vessels. It is expected that G&G survey vessels would be outfitted with appropriate lighting for navigational safety. While vessel collisions are unlikely during daylight hours with good visibility, seabird collisions may occur during hours of darkness or during periods of restricted visibility such as during rain or fog (Boehlert et al., 2008; Thompson et al., 2008).

Seismic survey vessels, which account for most of the project-related vessel traffic associated with the proposed action, travel at a speed of approximately 4.5 kn (8.3 km/hr). Because of their slow speed, there is little potential for G&G vessels to collide with birds. The issue of vessel noise is discussed separately in **Section 5.3.3**.

5.4.4. Effects on Fishes

Vessel traffic is expected to have little or no effect on the listed fish species. The G&G vessels included in the proposed action would be similar to other types of existing vessel traffic in the region. Two of the listed fishes, the smalltooth sawfish and shortnose sturgeon, are relatively rare in the BA Area and are unlikely to be exposed to G&G vessel traffic. The Atlantic sturgeon, alewife, and blueback herring are more common. Except for the Atlantic sturgeon as discussed below, vessel strikes have not been identified as a threat for any of the fish species evaluated in the BA.

Vessel interactions have been documented for estuarine/riverine Atlantic sturgeon (Brown and Murphy, 2010). This phenomenon has been documented in the Delaware River estuary where the main channel is narrow relative to the beam and draft of large cargo vessels that regularly traverse these waters. Propeller wash from large vessels can entrain adult, bottom-dwelling sturgeon, causing direct injury from contact with the propellers. Mortalities, recorded primarily during spawning season as adult fish were moving upstream, would likely hamper recovery efforts of Atlantic sturgeon (Brown and Murphy, 2010). Although ship strikes within estuaries and rivers are a source of mortality for Atlantic sturgeon, it is not expected to be a problem in the open shelf of the BA Area where vessel traffic associated with most G&G activities would take place. Vessel strike mortality from G&G vessel traffic is expected to be negligible.

5.5. AIRCRAFT TRAFFIC AND NOISE

The BOEM anticipates that one or two aeromagnetic surveys may be conducted in the BA Area during the time period covered by the Programmatic EIS. The surveys would be conducted by fixed-wing aircraft flying at speeds of about 250 km/hr (135 kn) (Reeves, 2005). Based on aeromagnetic datasets posted by Fugro Gravity and Magnetic Services (2012) for the northern Gulf of Mexico, most offshore aeromagnetic surveys are flown at altitudes from 61-152 m (200-500 ft) and collect 15,000-60,000 line km (9,320-37,282 line mi) of data. Line spacing varies depending on the objectives, but typical grids are 0.5 by 1.0 mi or 1.0 by 1.0 mi. A broad scale survey may be flown at higher altitudes (e.g., 305 m [1,000 ft]) and use wider line spacing (e.g., 4 by 12 mi or 8 by 24 mi). A fixed-wing aircraft typically acquires 20,000 line km (12,427 line mi) of useful data per month (Reeves, 2005). Therefore, it is expected that a typical aeromagnetic survey may require 1-3 months to complete. Based on the scale of aeromagnetic surveys that have been conducted in the northern Gulf of Mexico, an individual survey probably would cover less than 10 percent of the BA Area.

Helicopters are a potential source of aircraft noise during drilling of COST wells and shallow test wells. The oil and gas scenario assumes that up to three COST wells and up to five shallow test wells would be drilled in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. It is expected that drilling activities would be supported by a helicopter making one round-trip daily between the drilling rig and onshore support base. Neither the well locations nor the location of potential helicopter support bases are known at this programmatic stage.

Both helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft are generally below 500 Hz (Richardson et al., 1995). Richardson et al. (1995) reported received SPLs (in water) from aircraft flying at an altitude of 152 m (500 ft) were 109 dB re 1 µPa for a Bell 212 helicopter and 101 dB re 1 µPa for a small, fixed-wing aircraft (B-N Islander). Helicopters are about 10 dB louder than fixed-wing aircraft of similar size (Richardson et al., 1995). Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles greater than 13º from the vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m (500 ft) that is audible in air for 4 min may be detectable underwater for only 38 s at 3 m (10 ft) depth and for 11 s at 18 m (59 ft) depth (Richardson et al., 1995).

All aircraft would be expected to follow U.S. Department of Transportation(USDOT) FAA guidance (USDOT, FAA, 2004), which recommends a minimum altitude of 610 m (2,000 ft) when flying over noise-sensitive areas such as parks, wildlife refuges, and wilderness areas. Based on corporate policies for helicopter companies in the Gulf of Mexico, helicopters would be expected to maintain a minimum altitude of 213 m (700 ft) while in transit offshore (USDOI, MMS, 2007b). In practice, offshore support helicopters typically fly at higher altitudes ranging from 229-716 m (750-2,350 ft) depending on the distance and direction.

5.5.1. Effects on Marine Mammals

Aeromagnetic surveys have the potential to disturb marine mammals because of the relatively low altitude, typically 61-152 m (200-500 ft). The NMFS considers that low-flying aircraft could result in Level B (behavioral) harassment (Scholik-Shlomer et al., 2011). Helicopters in support of COST well drilling are unlikely to disturb marine mammals because they typically fly at higher altitudes.

Potential IPFs to marine mammals from aircraft traffic and noise include noise and physical (visual) disturbance. Noises generated by project-related aircraft that are directly relevant to marine mammals include both airborne sounds to individual mammals resting on the sea surface and underwater sounds from air-to-water transmission from passing aircraft. Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeed during aeromagnetic surveys (250 km/hr [135 kn]) and these physical variables, exposure of individual marine mammals to aircraft-related noise (including both airborne and underwater noise) is expected to be brief.

The physical presence of low-flying aircraft can disturb marine mammals, particularly individuals resting on the sea surface. Observations made from low altitude aerial surveys report behavioral responses of marine mammals are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction (Efroymson et al., 2000; Smultea et al., 2008). Minke whales have responded to helicopters at an altitude of 230 m (750 ft) by changing course or slowly diving (Leatherwood et al., 1982). Observational data of marine mammals exposed to sound from other sources (i.e., non-aircraft) may also be relevant in evaluating aircraft-based noise exposure impacts. For example, Frankel and Clark (1998) note that humpback whales exposed to low frequency sound may be responding to features of the source of the sound such as sound gradient or changes in the frequency spectrum rather than to the level itself.

Based on the scale of aeromagnetic surveys that have been conducted in the northern Gulf of Mexico, it is expected that an individual survey in the Atlantic would cover less than 10 percent of the BA Area and may require 1-3 months to complete. Line spacing varies depending on the objectives, but typical grids are 0.5 by 1.0 mi or 1.0 by 1.0 mi. Based on the short duration of potential exposure to aircraft-related noise and visual disturbance at any given location when an aircraft passes over, it is expected that effects on marine mammals would be limited to brief behavioral responses. Because of the grid spacing and the movement of marine mammals, multiple exposures could occur in some instances.

Helicopter traffic may also result in brief behavioral responses, but the potential for impacts is much lower because of the higher altitude and the limited extent of the traffic. Helicopters are expected to maintain a minimum altitude of 213 m (700 ft) when flying in transit offshore (USDOI, MMS, 2007b), but in practice, offshore support helicopters typically fly at higher altitudes ranging from 229-716 m (750-2,350 ft) depending on the distance and direction. The oil and gas scenario assumes that up to three COST wells and up to five shallow test wells would be drilled in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. It is expected that drilling activities would be supported by a helicopter making one round-trip daily between the drilling rig and onshore support base. Neither the well locations nor the location of potential helicopter support bases are known at this programmatic stage. It is expected that the helicopter would follow the same route each day. Based on the short duration of potential exposure to aircraft-related noise and visual disturbance at any given location when the helicopter passes over, it is expected that effects on marine mammals would be limited to brief behavioral responses. Because of the daily round trips and the movement of marine mammals, multiple exposures could occur in some instances.

Overall, given the low number of anticipated aircraft flights and that most are 700 ft altitude or above, air traffic is expected to affect but not adversely affect listed marine mammals.

5.5.2. Effects on Sea Turtles

Aeromagnetic surveys have the potential to disturb sea turtles because of the altitude (typically 61-152 m [200-500 ft]. Helicopters in support of COST well drilling are unlikely to disturb sea turtles because they typically fly at higher altitudes.

Noises generated by project-related survey aircraft that are directly relevant to sea turtles include both airborne sounds to individual turtles on the sea surface and underwater sounds from air-to-water transmission from passing aircraft. Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeed during aeromagnetic surveys (250 km/hr [135 kn]) and these physical variables, exposure of individual sea turtles to aircraft-related noise (including both airborne and underwater noise) is expected to be brief.

The physical presence of low-flying aircraft can disturb sea turtles, particularly individuals resting on the sea surface. Behavioral responses to flying aircraft could include diving or rapid changes in swimming speed or direction. However, because sea turtles spend most of their time submerged, they are unlikely to be exposed to visual disturbance.

Based on the scale of aeromagnetic surveys that have been conducted in the northern Gulf of Mexico, it is expected that an individual survey in the Atlantic would cover less than 10 percent of the BA Area and may require 1-3 months to complete. Line spacing varies depending on the objectives, but typical grids are 0.5 by 1.0 mi or 1.0 by 1.0 mi. Based on the short duration of potential exposure to aircraft-related noise and visual disturbance at any given location when an aircraft passes over, it is expected that effects on sea turtles would be limited to brief behavioral responses. Because of the grid spacing and the movement of sea turtles, multiple exposures could occur in some instances.

Helicopter traffic may also result in brief behavioral responses in sea turtles, but the potential for impacts is much lower because of the higher altitude and the limited extent of the traffic. Helicopters are expected to maintain a minimum altitude of 213 m (700 ft) when flying in transit offshore (USDOI, MMS, 2007b), but in practice, offshore support helicopters typically fly at higher altitudes ranging from 229-716 m (750-2,350 ft) depending on the distance and direction. The oil and gas scenario assumes that up to three COST wells and up to five shallow test wells would be drilled in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. It is expected that drilling activities would be supported by a helicopter making one round-trip daily between the drilling rig and onshore support base. Neither the well locations nor the location of potential helicopter support bases are known at this programmatic stage. It is expected that the helicopter would follow the same route each day. Based on the short duration of potential exposure to aircraft-related noise and visual disturbance at any given location when the helicopter passes over, it is expected that effects on sea turtles would be limited to brief behavioral responses. Because of the daily round trips and the movement of sea turtles, multiple exposures could occur in some instances.

Overall, given the low number of anticipated aircraft flights and that most are 700 ft altitude or above, air traffic is expected to affect but not adversely affect listed sea turtles.

5.5.3. Effects on Birds

Both aeromagnetic surveys and helicopter traffic in support of COST well drilling have the potential to disturb birds or result in collisions (bird strikes).

Noises generated by project-related survey aircraft that are directly relevant to birds include airborne sounds from passing aircraft for both individual birds on the sea surface and birds in flight above the sea surface. Both helicopters and fixed-wing aircraft generate noise from their engines, airframe, and propellers. The dominant tones for both types of aircraft are generally below 500 Hz (Richardson et al., 1995) and within the airborne auditory range of birds. Aircraft noise entering the water depends on aircraft altitude, the aspect (direction and angle) of the aircraft relative to the receiver, and sea surface conditions. The level and frequency of sounds propagating through the water column are affected by water depth and seafloor type (Richardson et al., 1995). Because of the expected airspeed (250 km/hr [135 kn]), noise generated by survey aircraft is expected to be brief in duration, and birds may return to relaxed behavior within 5 min of the overflight (Komenda-Zehnder et al., 2003); however, birds can be disturbed up to 1 km away from an aircraft (Efroymson et al., 2000).

The physical presence of low-flying aircraft can disturb marine and coastal birds, including those on the sea surface as well as in flight. Behavioral responses to flying aircraft include flushing the sea surface into flight or rapid changes in flight speed or direction. These behavioral responses can cause collision with the survey aircraft. However, Efroymson et al. (2000) reported that the potential for bird collision decreases for aircrafts flying at speed greater than 150 km/h. In addition, the FAA recommends that aircraft fly at a minimum altitude of 610 m (2,000 ft) or more above ground over noise sensitive areas such as National Parks, NWRs, Waterfowl Production Areas, and Wilderness Areas (USDOT, FAA, 2004).

Based on the scale of aeromagnetic surveys that have been conducted in the northern Gulf of Mexico, it is expected that an aeromagnetic survey in the Atlantic would cover less than 10 percent of the BA Area and may require 1-3 months to complete. Line spacing varies depending on the objectives, but typical grids are 0.5 by 1.0 mi or 1.0 by 1.0 mi. Based on the short duration of potential exposure to aircraft-related noise and the small risk of a collision at any given location when an aircraft passes over, it is expected that effects on listed birds would be limited to brief behavioral responses. Because of the grid spacing and the movement of birds, multiple exposures could occur in some instances.

Piping plovers and red knots are shorebirds that are unlikely to be affected by aircraft traffic and noise from the proposed action. They are not expected to be common in offshore airspace where most of the aeromagnetic survey activity would occur. When in transit across shorelines, aircraft and helicopters would be expected to maintain FAA-recommend altitudes that would avoid most potential disturbance of birds along the shoreline and minimize the risk of bird strikes.

Roseate terns and Bermuda petrels are seabirds that are more likely to occur in offshore airspace where most of the aeromagnetic survey activity would occur. However, because of low densities of seabirds over the open ocean, the potential for disturbance or bird strikes is low. There are no breeding or feeding areas where these birds would be expected to concentrate within the BA Area. Therefore, aircraft activities and noise is not expected to affect listed bird species.

5.5.4. Effects on Fishes

Aircraft traffic and noise is not expected to have any detectable effects on listed fish species given the distance between aircraft operation and listed fish species.

5.6. Trash and Debris

Survey operations generate trash made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations. Occasionally, some personal items such as hardhats and personal flotation devices are accidentally lost overboard.

It is prohibited to discharge trash and debris (33 CFR 151.51-77) unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-mm mesh screen. Discharge of plastic is prohibited regardless of size. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. The BOEM assumes vessel operators would discharge trash and debris only after it has passed through a comminutor and that all other trash and debris would be returned to shore.

Current USCG and USEPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition, over the last several years, companies operating offshore have developed and implemented trash and debris reduction and improved handling practices to reduce the amount of offshore trash that could potentially be lost into the marine environment. These trash management practices include substituting paper and ceramic cups and dishes for those made of styrofoam, recycling offshore trash, and transporting and storing supplies and materials in bulk containers when feasible and have resulted in a reduction of accidental loss of trash and debris.

Under the proposed action, all authorizations for shipboard surveys would include guidance for marine debris awareness. The guidance would be similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012). All vessel operators, employees, and contractors actively engaged in G&G surveys must be briefed on marine trash and debris awareness elimination as described in the NTL except that BOEM will not require applicants to undergo formal training or post placards. The applicant would be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment where it could affect protected species.

Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, impacts on listed marine mammals, sea turtles, birds, or fishes are expected to be avoided.

5.6.1. Effects on Marine Mammals

Lost and discarded marine debris, particularly those items made of synthetic materials, is a major form of marine pollution. The types of objects most commonly encountered in offshore waters include plastic bags, wrappers, bottles, cups, and raw plastic pellets; synthetic rope; glass bottles; metal cans; lumber; and cigarette butts (Laist, 1996, 1997; Barnes et al., 2009; Gregory, 2009). Factors that account for recent increases in marine debris include unlawful disposal practices, proliferation of synthetic materials that are resistant to degradation in the marine environment, and increasing numbers of people using and disposing of more synthetic items.

Marine debris poses two types of potentially negative impacts to marine biota, including marine mammals: (1) entanglement, and (2) ingestion. Records suggest that entanglement is a far more likely cause of mortality to marine mammals than ingestion-related interactions. Entanglement records for marine mammals show that entanglement is most common in pinnipeds, less common in mysticete cetaceans, and rare among odontocete cetaceans (Laist et al., 1999). Entanglement data for mysticete cetaceans may reflect a high interaction rate with active fishing gear rather than with marine debris. Abrasion and chafing scars from rope and line have been reported on numbers of photographed North Atlantic right whales in the western North Atlantic. These scars were attributed to entanglement in fishing gear (USDOC, NMFS, 2005). Entanglement records for odontocete cetaceans that are not clearly related to bycatch in active fisheries are almost absent (Laist, 1996).

G&G survey operations generate trash made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations. It is prohibited to discharge trash and debris (33 CFR 151.51-77) unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Some personal items, such as hardhats and personal flotation devices, are occasionally accidentally lost overboard. However, USCG and USEPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. Under the proposed action, all authorizations for offshore G&G activities would include guidance for the handling and disposal of marine trash and debris, similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012).

Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities would be released into the marine environment. Therefore, debris entanglement and ingestion impacts on marine mammals are expected to be avoided and are not expected to affect list marine mammals.

5.6.2. Effects on Sea Turtles

Lost and discarded marine debris, particularly those items made of synthetic materials, is a major form of marine pollution (Laist, 1997). Marine debris poses two types of negative impacts to sea turtles: (1) entanglement, and (2) ingestion. The USDOC, NMFS and USDOI, FWS (2008) note that loggerhead turtles have been found entangled in a wide variety of materials, including steel and monofilament line, synthetic and natural rope, plastic onion sacks, and discarded plastic netting. From 1997-2005, 1.6 percent of stranded loggerheads found on Atlantic and Gulf of Mexico beaches were entangled in fishing gear. Monofilament line appears to be the principal source of entanglement for loggerheads in U.S. waters (0.9 percent; 1997-2005 average), followed by pot/trap line (0.4 percent; 1997-2005 average) and fishing net (0.3 percent; 1997-2005 average). Less than 1 percent of stranded sea turtles in 2005 were found entangled in other marine debris (NMFS, unpublished data, as cited in USDOC, NMFS and USDOI, FWS, 2008).

G&G survey operations generate trash made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations. It is prohibited to discharge trash and debris (33 CFR 151.51-77) unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Some personal items, such as hardhats and personal flotation devices, are occasionally accidentally lost overboard. However, USCG and USEPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness. The guidance would be similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012).

Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities would be released into the marine environment, which appreciably reduces the likelihood of sea turtles encountering marine debris from the proposed activity. Therefore, debris entanglement and ingestion impacts on sea turtles are expected to be avoided and are not expected to affect list sea turtles..

5.6.3. Effects on Birds

Ingested debris may have three specific effects on seabirds: (1) physical damage and blocking of the digestive tract, (2) impairment of foraging efficiency, and (3) the release of toxic chemicals. The severity of these effects depends upon the types of debris ingested and their retention time within seabirds (Ryan, 1990). Seabirds that feed by surface-seizing, such as the roseate tern and Bermuda petrel, are among the most susceptible to ingesting floating plastic debris (Azzarello and Van Vleet, 1987; Ryan, 1987). Seabirds that feed by different methods may also ingest marine debris, suggesting that all seabirds are susceptible to plastic pollution (Tourinho et al., 2010).

Plastic is found in the surface waters of all of the world’s oceans and poses a potential hazard to most marine life, including seabirds through entanglement or ingestion (Laist, 1987). The ingestion of plastic by marine and coastal birds can cause obstruction of the gastrointestinal tract, which can result in mortality. Plastic ingestion can also include blockage of the intestines and ulceration of the stomach. In addition, plastic accumulation in seabirds has also been shown to be correlated with the body burden of polychlorinated biphenyls (PCBs), which can cause lowered steroid hormone levels and result in delayed ovulation and other reproductive problems (Pierce et al., 2004).

Trash made of paper, plastic, wood, glass, and metal is generated during G&G survey operations. Most of this trash is associated with galley and offshore food service operations. It is prohibited to discharge trash and debris (33 CFR 151.51-77) unless it is passed through a comminutor (a machine that breaks up solids) and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste. Some personal items, such as hardhats and personal flotation devices, are occasionally accidentally lost overboard. However, USCG and USEPA regulations require operators to become proactive in avoiding accidental loss of solid waste items by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition, all authorizations for shipboard surveys would include guidance for marine debris awareness. The guidance would be similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012).

Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities would be released into the marine environment, which appreciably reduces the likelihood of birds encountering marine debris from the proposed activity. Therefore, debris entanglement and ingestion impacts on birds are expected to be avoided and are not expected to affect listed birds.

5.6.4. Effects on Fishes

None of the listed fish species is likely to ingest trash or debris. Trash and debris have not been identified as a significant threat for shortnose sturgeon, Atlantic sturgeon, alewife, or blueback herring. However, because of their long, toothed rostrum, smalltooth sawfish are readily entangled in nets, ropes, monofilament line, discarded pipe sections, and other debris (Seitz and Poulakis, 2006).

Under the proposed action, all authorizations for shipboard surveys would include guidance for marine debris awareness. The guidance would be similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012). All vessel operators, employees, and contractors actively engaged in G&G surveys must be briefed on marine trash and debris awareness elimination as described in the NTL except that BOEM will not require applicants to undergo formal training or post placards. The applicant would be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment where it could affect protected species.

Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, impacts on smalltooth sawfish and other listed fish species are expected to be avoided and are not expected to affect listed fish species.

5.7. SEAFLOOR DISTURBANCE

Sources of seafloor disturbance in the proposed action include

- bottom sampling activities in all three program areas;
- placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor for various activities in the oil and gas program;
- COST well and shallow test drilling in the oil and gas program; and
- placement of bottom-founded monitoring buoys in the renewable energy program.

The BOEM will require site-specific information regarding potential archaeological resources and sensitive benthic communities (including hard/live bottom areas, deepwater coral communities, and chemosynthetic communities) prior to approving any G&G activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the BA Area. The BOEM will use this information to ensure that physical impacts to archaeological resources or sensitive benthic communities are avoided.

The BOEM has not designated specific benthic locations for avoidance in the BA Area. However, likely areas for avoidance would include known hard/live bottom areas, known deepwater coral locations including *Lophelia* and *Oculina* coral sites, deepwater coral Habitat Areas of Particular Concern, deepwaterMarine Protected Areas, Gray's Reef National Marine Sanctuary, the Charleston Bump area, and the walls of submarine canyons. All authorizations for G&G surveys proposed within or near these areas would be subject to the review noted above to facilitate avoidance. The BOEM has not developed specific buffer zones for sensitive benthic communities in the Atlantic, but it is expected that they would be similar to those that BOEM uses in the Gulf of Mexico. The BOEM would not authorize seafloor-disturbing activities in marine sanctuaries in the BA Area except in consultation with NOAA under the National Marine Sanctuaries Act. Setbacks of 152 m (500 ft) for seafloor-disturbing activities would be expected that could be modified by consultations with NOAA under the National Marine Sanctuaries Act for specific activities in proximity to a National Marine Sanctuary.

For the renewable energy program, BOEM has issued "*Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585*" (USDOI, BOEM, 2011b). The guidelines specify that a site characterization survey must reliably cover any portion of the site that would be affected by seafloor-disturbing activities. The guidelines recommend avoidance as a primary mitigation strategy for objects of historical or archaeological significance. The applicant has the option to demonstrate through additional investigations that an archaeological resource either does not exist or would not be adversely affected by the seafloor/bottom-disturbing activities. While site characterization activities covered by these guidelines could identify other resource types (e.g., benthic communities), recommendations for conducting and reporting the results of other baseline collection studies (e.g., biological) would be provided by BOEM in separate guidelines.

Bottom Sampling Activities

The proposed action scenario includes bottom sampling activities in all three program areas. These include

- 50-300 core or grab samples in the oil and gas program;
- 3,106-9,969 core or grab samples in the renewable energy program; and
- 1-8 geologic cores, 60-320 grab samples, and 90-600 vibracores in the marine minerals program.

Collection of each sample is estimated to disturb an area of approximate 10 m^2 (108 ft^2), although the actual area of the core or grab extracted may be much smaller. If all of the samples in the proposed action scenario were collected, the total seafloor disturbance would be about 11 ha (27 ac), which represents 0.00001 percent of the BA Area.

Sampling for oil and gas exploration would be conducted at specific lease blocks where structures such as drilling rigs, platforms, or pipelines may be installed. The blocks could be anywhere within the Mid- or South Atlantic Planning Areas and cannot be predicted as there are currently no active oil and gas leases in the Atlantic OCS.

Sampling for renewable energy projects would occur at specific sites consisting of one or more OCS blocks in water depths less than 100 m (328 ft) and along potential cable routes to shore. Offshore Delaware, Maryland, and Virginia, the likely sampling locations would be within designated WEAs (USDOI, BOEM, 2012a). North Carolina has identified 500 OCS blocks of interest, but it is likely that sampling would occur within only a small subset of these blocks. Specific locations have not been identified for the South Atlantic states.

Sampling activities for marine minerals would be conducted at specific borrow sites in water depths less than 30 m (98 ft). Much of the marine minerals activity is expected to occur within existing borrow sites offshore the Mid-Atlantic and South Atlantic states (see **Figure A-3** for locations). By design, the sampling locations are expected to be almost exclusively sand bottom.

Placement of Anchors, Nodes, Cables, and Sensors

Certain surveys in oil and gas exploration require placement of anchors, nodes, cables, sensors, or other equipment on or in the seafloor. Ocean bottom cable and nodal surveys, vertical cable surveys, CSEM surveys, and MT surveys involve placement of sensors and/or anchors on the seafloor. In VSP surveys, receivers are placed in boreholes in the seafloor. Each of these activities would temporarily affect a small area of seafloor. After a survey is completed, the sensors are removed; anchors are either removed or left in place (if biodegradable). The blocks where these surveys would be conducted could be anywhere within the Mid- or South Atlantic Planning Areas and cannot be predicted as there are currently no active oil and gas leases in the Atlantic OCS. The total area of seafloor disturbed has not been calculated.

COST Wells and Shallow Test Drilling

The oil and gas scenario assumes that up to three COST wells and up to five shallow test wells would be drilled in the Mid- or South Atlantic Planning Areas during the time period of the Programmatic EIS. Locations for COST wells and shallow test wells are unknown. However, it is likely that there would be some interest in a test program for gas hydrates within the proposed action scenario period, at least in the South Atlantic Planning Area in the Blake Plateau region. These wells could be considered either COST wells or shallow test drilling, depending on the penetration depth.

COST wells and shallow test wells would be drilled using conventional rotary drilling techniques. Seafloor disturbance would result from anchoring (if a moored drilling rig was used), placing a well template on the seafloor, and jetting the well. The area of seafloor disturbance varies with the type of rig chosen to drill a well, which depends primarily on water depth (USDOI, MMS, 2007b). Jack-up rigs are used in shallow water and disturb approximately 1 ha (2.5 ac) for each location. Semisubmersibles can be operated in a wide range of water depths and disturb about 2-3 ha (5-7 ac), depending on their mooring configurations. In water depths >600 m (>1,969 ft), dynamically positioned drillships could be used; these drillships disturb only a very small area where the bottom template and wellbore are located, approximately 0.25 ha (0.62 ac).

For this impact analysis, the area of seafloor disturbance is assumed to average about 2 ha (5 ac) per well. If all of the COST wells and shallow test wells in the proposed action scenario were drilled, the total seafloor disturbance would be about 16 ha (40 ac), or about 0.00002 percent of the BA Area.

Bottom-Founded Meteorological Buoys

As part of the renewable energy program, lessees may install bottom-founded meteorological buoys. The Programmatic EIS assumes that lessees would choose to install buoys instead of meteorological towers. These buoys would be anchored at fixed locations and regularly collect observations from many different atmospheric and oceanographic sensors.

Meteorological buoys would typically be towed or carried aboard a vessel to the installation location. Once at the location site, the buoy would be either lowered to the surface from the deck of the transport vessel or placed over the final location and then the mooring anchor dropped. A boat-shaped buoy in shallower waters of the BA Area may be moored with an all-chain mooring, while a larger discus-type buoy would use a combination of chain, nylon, and buoyant polypropylene materials (USDOC, NDBC, 2011). After installation, the transport vessel would remain in the area for several hours while technicians configure proper operation of all systems. Buoys would typically take 1 day to install. Transport and installation vessel anchoring for 1 day is anticipated for these types of buoys. Decommissioning of buoys is essentially the reverse of the installation process.

The proposed action scenario includes 7-38 buoys that may be installed within the BA Area during the time period of the Programmatic EIS. Anchors for boat-shaped and discus-shaped buoys would have a footprint of about 0.55 m^2 (6 ft^2) and an anchor sweep of about 3.4 ha (8.5 ac) (USDOI, BOEM, 2012a). The larger anchor sweep area is used to estimate seafloor disturbance. If all of the monitoring buoys in the proposed action scenario were installed, the total seafloor disturbance would be about 129 ha (319 ac), or about 0.0002 percent of the BA Area.

5.7.1. Effects on Marine Mammals

Seafloor disturbance is not expected to have any detectable effect on the listed marine mammals in this analysis. The listed whale species do not use benthic or seafloor habitats to any extent. The benthic habitats used by the Florida manatee are in coastal, inland waters, which are not within the BA Area and would not be locations for G&G activities under the proposed action.

5.7.2. Effects on Sea Turtles

Seafloor disturbance is not expected to have any detectable effect on the sea turtles in this analysis. Green, hawksbill, Kemp's ridley, and loggerhead turtles use soft bottom benthic habitats for foraging. However, the extent of seafloor disturbance from all of the G&G activities in the proposed action is a negligible percentage of the available soft bottom habitat in the BA Area. Hawksbill turtles feed in coral and hard bottom areas, which would be avoided (see **Section 7**), and therefore no impacts are expected.

5.7.3. Effects on Birds

Seafloor disturbance is not expected to have any detectable effect on the listed bird species in this analysis. They do not use offshore benthic or seafloor habitats.

5.7.4. Effects on Fishes

Seafloor disturbance could affect the three demersal species included in this analysis (smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon) because all three species inhabit soft bottom areas. The alewife and blueback herring do not use offshore benthic habitats and would not be affected.

Smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon all inhabit soft bottom areas, and therefore they could be affected by seafloor disturbance. However, the extent of seafloor disturbance from all of the G&G activities in the proposed action is a negligible percentage of the available soft bottom habitat in the BA Area. If all of the samples in the proposed action scenario were collected, the total seafloor disturbance would be about 11 ha (27 ac), which represents 0.00001 percent of the BA Area. In addition, the occurrence of smalltooth sawfish and shortnose sturgeon is so spatially limited that exposure to seafloor disturbance caused by the proposed action is extremely unlikely. Smalltooth sawfish normally inhabit shallow waters of less than 10 m (33 ft) off southwest Florida, with only occasional excursions north of Florida. Shortnose sturgeon is an estuarine and riverine species that rarely enters marine waters of the BA Area. Given the limited extent of seafloor disturbance in the proposed action, it is unlikely that either species would come into contact with affected areas.

Because of its distribution, the Atlantic sturgeon is more likely than the other demersal species to come into contact with areas of seafloor disturbance from the proposed action. Atlantic sturgeon occur on the shelf in water depths of less than 21.3 m (70 ft) during fall and winter months, preferring shell, gravel, or sand bottoms. Areas of particular concentration have been identified in water depths between 9.1 and 21.3 m (30 and 70 ft) offshore Virginia and near sand shoals adjacent to Oregon Inlet, North Carolina (Laney et al., 2007). Depending on the survey or sampling location, Atlantic sturgeon could be temporarily displaced from areas of concentration during activities that disturb the seafloor or while bottom-deployed equipment is in place. However, the extent of seafloor disturbance is a negligible percentage of the available soft bottom habitat in the BA Area. Moreover, no biologically vital behaviors (e.g., spawning) occur in these locations, therefore it is unlikely that seafloor disturbance would have any affect on Atlantic sturgeon.

5.8. DRILLING DISCHARGES

The oil and gas scenario assumes that up to three COST wells would be drilled in the BA Area during the time period of the Programmatic EIS. Conventional rotary drilling techniques, the same as those routinely used for drilling oil and gas exploration and development wells, are used to drill COST wells. During the process, drilling fluid and cuttings are discharged, disperse in the water column, and accumulate on the seafloor (NRC, 1983; Neff, 1987; Neff et al., 2000).

During the initial stage of drilling, a large diameter surface hole is jetted a few hundred meters into the seafloor. A National Pollutant Discharge Elimination System (NPDES) permit must be obtained from the USEPA in order to discharge drilling fluids and cuttings. At this stage, the cuttings and seawater used as drilling fluid are discharged onto the seafloor. A continuous steel pipe known as a surface casing is lowered into the hole and cemented in place. A blowout preventer is installed on the top of the surface casing to prevent water or hydrocarbons from escaping into the environment. Once the blowout preventer is fully pressure tested, the next section of the well is drilled.

The marine riser is a pipe with special fittings that establishes a seal between the top of the wellbore and the drilling rig. After it is set, all drilling fluid and cuttings are returned to the drilling rig and passed through a solids control system designed to remove cuttings and silt so that the drilling fluids may be recirculated downhole. The drill cuttings, typically sand or gravel-sized with any residual drilling mud attached, are then discharged via the shale chute.

The only drilling fluids in widespread use on the OCS are either water-based fluids (WBFs) or synthetic-based fluids (SBFs). Typically, the upper portion of exploration wells are drilled with WBF to a depth in the range of 800-2,000 m (2,625-6,562 ft) and, following “switchover,” the remainder is drilled with SBF (USDOI, MMS, 2007b).

During well intervals when WBF systems are used, cuttings and adsorbed WBF solids are discharged to the ocean at a rate of 0.2-2.0 m^3/hr (Neff, 1987). Overboard discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and elevated concentrations of some trace metals (NRC, 1983; Neff, 1987). In shallow environments, WBFs are rapidly dispersed in the water column immediately after discharge and quickly descend to the seafloor, whereas in deeper water, fluids discharged at the sea surface are dispersed over a wider area (Neff, 1987).

Synthetic-based fluids are manufactured hydrocarbons without aromatic hydrocarbons and polycyclic aromatic hydrocarbons characteristic of oil-based fluids, which are not used on the U.S. OCS. When SBF systems are used, the SBF is returned to shore for recycling, and the only discharge consists of SBF adhering to cuttings. Retention on cuttings is subject to regulatory limits; for example, under the current NPDES permit for USEPA Region IV in the Gulf of Mexico, the limits are 6.9 percent for internal olefins and 9.4 percent for esters (USEPA, 2010). Cuttings wetted with SBF typically settle close to the discharge point and affect the local sediments and any benthic invertebrates in proximity (Neff et al., 2000; Continental Shelf Associates, Inc., 2006).

The average exploration well in the Gulf of Mexico is approximately 3,674 m (12,055 ft) below mudline (USDOI, MMS, 2007b) and is equivalent to an Atlantic COST well in depth. Each well discharges about 7,000-9,700 barrels (bbl) of WBF and 1,500-2,500 bbl of cuttings (USEPA, 1993, 2000). Assuming an average of 2,000 bbl of cuttings and 8,350 bbl of drilling fluid discharged per well, the total volumes for 1-3 COST wells would range from 2,000-6,000 bbl of cuttings and 8,350-25,050 bbl of drilling fluid.

Shallow test wells for gas hydrate would also result in drilling fluid and cuttings discharges. The oil and gas exploration scenario estimates up to five shallow test wells in the BA Area. It is likely that, at the least, there would be some interest within the proposed action scenario period in a test program for gas hydrates in the South Atlantic Planning Area in the Blake Plateau region. Gas hydrate wells are from 152 m (500 ft) to a few thousand feet deep because gas hydrates are found in shallow depths within the sediment due to the physico-chemical requirements for their stability. In the Gulf of Mexico, test programs for gas hydrates were fielded in 2005 (Birchwood et al., 2008) and 2009 (Boswell et al., 2009). The deepest well for the 2009 test program was 1,122 m (3,680 ft) below mudline. Wells this shallow would yield a few hundred barrels of drilling fluid and cuttings each.

5.8.1. Effects on Marine Mammals

Drilling discharges are not likely to have any detectable effect on marine mammals (USDOI, MMS, 2007b). The main impacts would be temporary turbidity in the water column and localized alteration of the benthic environment around individual wellsites. A plume of turbid water could extend a few kilometers from a wellsite and persist for hours after each discharge (Neff, 1987). Due to the localized and transient nature of the water quality impacts, the discharges are unlikely to significantly affect foraging or other activities by marine mammals. Discharged cuttings may be temporarily suspended in the water column and would accumulate on the seafloor, but the listed whale species do not use benthic or seafloor habitats to any extent. The benthic habitats used by the Florida manatee are in coastal, inland waters, which are remote from locations for COST wells or shallow test drilling activities under the proposed action.

5.8.2. Effects on Sea Turtles

Drilling discharges are not likely to have any detectable effect on sea turtles (USDOI, MMS, 2007b). The main impacts would be temporary turbidity in the water column and localized alteration of the benthic environment around individual wellsites. A plume of turbid water could extend a few kilometers from a wellsite and persist for hours after each discharge (Neff, 1987). Due to the localized and transient nature of the water quality impacts, the discharges are unlikely to significantly affect foraging or other activities by sea turtles. Discharged cuttings may be temporarily suspended in the water column and would accumulate on the seafloor. Although green, hawksbill, Kemp's ridley, and loggerhead turtles use soft bottom benthic habitats for foraging, the extent of benthic habitat impacts from drilling discharges is a negligible percentage of the available soft bottom habitat in the BA Area. Hawksbill turtles feed in coral and hard bottom areas, which would be avoided (see **Section 7**), and therefore no impacts are expected.

5.8.3. Effects on Birds

Drilling discharges are not likely to have any detectable effect on marine and coastal birds (USDOI, MMS, 2007b). Piping plovers and red knots would not be exposed to drilling discharges because they are coastal inhabitants. The roseate tern and Bermuda petrel could encounter temporary turbidity in the water column, which could extend a few kilometers from a wellsite and persist for hours after each discharge. Because of the localized and transient nature of the water quality impacts, the discharges are unlikely to affect foraging or other activities by these birds.

5.8.4. Effects on Fishes

The primary environmental concerns related to the discharge of fluids and cuttings are increased water column turbidity and accumulation of drilling muds and cuttings on the seafloor.

Turbidity during drilling discharges could interfere with visual feeding by water column fishes such as the alewife and blueback herring. Turbidity could extend a few kilometers from a wellsite and persist for hours after each discharge (Neff, 1987). However, because of the localized and transient nature of the turbidity, effects on alewife and blueback herring would not be significant.

Benthic deposition is the main issue for demersal species such as smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon because all three species inhabit soft bottom areas. Deposition of drilling fluids and cuttings can increase the organic load of the benthos and promote anoxic conditions. Drilling discharges can also alter the ambient sediment grain size and alter the concentrations of some metals. Drilling fluid and cuttings deposition would result in localized changes to the benthic infaunal community, including infaunal species important to benthic feeding fishes.

However, the extent of benthic habitat impacts from drilling discharges is a negligible percentage of the available soft bottom habitat in the BA Area. Assuming a typical effect radius of 500 m (1,640 ft), the affected area around each wellsite would represent about 3 percent of the seafloor within an OCS lease block and about 0.0001 percent of the BA Area. Soft bottom communities are ubiquitous regionally, and the impact on benthic habitat would be negligible on a regional basis.

In addition, the occurrence of smalltooth sawfish and shortnose sturgeon is so spatially limited that exposure to drilling discharges is extremely unlikely. Smalltooth sawfish normally inhabit shallow waters of less than 10 m (33 ft) off southwest Florida, with only occasional excursions north of Florida. Shortnose sturgeon is an estuarine and riverine species that rarely enters marine waters of the BA Area. Given the limited extent of drilling discharge impacts in the proposed action, it is unlikely that either species would come into contact with affected areas.

Because of its distribution, the Atlantic sturgeon is more likely than the other demersal species to come into contact with areas of benthic habitat impacts from drilling discharges. Atlantic sturgeon occur on the shelf in water depths of less than 21.3 m (70 ft) during fall and winter months, preferring shell, gravel, or sand bottoms. Areas of concentration have been identified in water depths between 9.1 and 21.3 m (30 and 70 ft) offshore Virginia and near sand shoals adjacent to Oregon Inlet, North Carolina (Laney et al., 2007). Depending on the drilling location, Atlantic sturgeon could be temporarily displaced from areas of concentration because of drilling discharges. However, the extent of altered seafloor habitat from drilling discharges would be a negligible percentage of the available soft bottom habitat in the BA Area. Moreover, no biologically vital behaviors (e.g., spawning) occur in these locations, and therefore it is unlikely that drilling discharges would have any effects on Atlantic sturgeon.

5.9. Accidental Fuel Spills

Vessel fuel capacities generally depend on vessel size, which varies according to the nature of the survey (for example, 3D surveys use larger vessels than 2D surveys). A large seismic survey vessel may carry between 100,000-1.1 million gal (2,380-27,000 bbl) of fuel, including diesel and fuel oil (CGGVeritas, 2011; Geophysical Service, Inc., 2011a,b). Smaller coastal vessels may carry several thousand gallons.

Vessels involved in G&G activities off the Mid-Atlantic and South Atlantic coasts could be involved in collisions or other accidents that result in a fuel spill. Spill size would depend on the type of vessel, the severity of the event, and whether the fuel storage is compartmentalized.

All G&G vessels are required to comply with USCG requirements relating to prevention and control of oil spills. Nevertheless, for the purposes of this analysis, a spill scenario was evaluated – a release of 1.2-7.1 bbl of diesel fuel caused by either a vessel collision or an accident during fuel transfer. The volume is based on spill statistics for the period 2000-2009 developed by the USDHS, USCG (2011b). During this period, there were 1,521-5,220 spills per year from vessels other than tankers and tank barges. Total annual spill volumes from these vessels ranged from 92,388-453,901 gal, resulting in average spill sizes ranging between 49.6 and 297.3 gal, or 1.2-7.1 bbl.

The likelihood of a fuel spill during seismic surveys or other G&G activities is expected to be remote. For example, there has never been a recorded oil/fuel spill during more than 54,000 nmi (100,000 km) of previous NSF-funded seismic surveys (NSF and USDOI, USGS, 2011).

The potential for impacts from a 1.2-7.1 bbl diesel fuel spill would depend greatly on the location of the spill, meteorological and oceanographic conditions at the time, and the speed with which cleanup plans and equipment could be employed. Diesel fuel is a refined petroleum product that is lighter than water. It may float on the water's surface or be dispersed into the water column by waves. It is assumed that spilled fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment. Small diesel spills (500-5,000 gal) will usually evaporate and disperse within a day or less, even in cold water (USDOC, NOAA, 2006); thus, seldom is there any oil on the surface for responders to recover. However, what is commonly referred to as "marine diesel" is often a heavier intermediate fuel oil that will persist longer when spilled. When spilled on water, diesel oil spreads very quickly to a thin film of rainbow and silver sheens, except for marine diesel, which may form a thicker film of dull or dark colors (USDOC, NOAA, 2006). There is the potential for a small proportion of the heavier fuel components to adhere to particulate matter in the upper portion of the water column and sink. Particulate matter contaminated with diesel fuel could eventually reach the benthos either within or outside the BA Area, depending upon spill location, water depth, ambient currents, and sinking rate.

5.9.1. Effects on Marine Mammals

The potential impacts of a small diesel spill (1.2-7.1 bbl) as evaluated for the proposed action could vary depending on the spill location and the meteorological and oceanographic conditions at the time.

However, in general, a small spill would be expected to disperse quickly in the open ocean and would not be likely to contact more than a few individual marine mammals. Prolonged exposure would not be likely for any individuals in the open ocean. A small spill would be unlikely to result in the death or life-threatening injury of individual marine mammals, or the long-term displacement of marine mammals from preferred feeding, breeding, or calving areas or migratory routes. Therefore, potential impacts to listed marine mammals within the BA Area are expected to affect but not adversely affect listed marine mammals.

Effects of spilled oil on marine mammals are discussed by Geraci and St. Aubin (1980, 1982, 1985, 1990) and Lee and Anderson (2005), as well as within spill-specific study results (e.g., *Exxon Valdez*; Frost and Lowry, 1994; Paine et al., 1996; Hoover-Miller et al., 2001; Peterson et al., 2003). Diesel fuel on the sea surface may affect marine mammals through various pathways: surface contact of the fuel with skin and other mucous membranes, inhalation of concentrated petroleum vapors, or ingestion of the fuel (direct ingestion or by the ingestion of oiled prey).

Whales and dolphins apparently can detect slicks on the sea surface but do not always avoid them (Geraci and St. Aubin, 1990; Smultea and Würsig, 1995). Therefore, they may be vulnerable to inhalation of hydrocarbon vapors, particularly those components of diesel fuel that are readily evaporated. Ingestion of the lighter hydrocarbon fractions found in diesel fuel can be toxic to marine mammals. Ingested diesel fuel can remain within the gastrointestinal tract and be absorbed into the bloodstream, thus irritating and/or destroying epithelial cells in the stomach and intestines. Certain constituents of diesel fuel (i.e., aromatic hydrocarbons, polycyclic aromatic hydrocarbons) include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolized by many organisms (Neff, 1990). Released diesel fuel may also foul the baleen fibers of mysticete whales, thereby impairing food gathering efficiency or resulting in the ingestion of diesel fuel or diesel fuel-contaminated prey.

A spill in offshore waters would be unlikely to affect manatees because of their coastal habitat preferences. There have been no experimental studies and only a handful of observations suggesting that oil has harmed any manatees (St. Aubin and Lounsbury, 1990). The types of impacts to manatees and dugongs from contact with oil include (1) asphyxiation due to inhalation of hydrocarbons, (2) acute poisoning due to contact with fresh oil, (3) lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum components into body tissues, (4) nutritional stress through damage to food sources, and (5) inflammation or infection and difficulty eating due to oil sticking to the sensory hairs around their mouths (USDOI, BOEM, 2012b). If oil reached coastal or inland waters, it could affect the quality or availability of aquatic vegetation upon which manatees feed. Also, this species is particularly vulnerable to vessel strikes. Spill response vessels (like all G&G project vessels) would be subject to BOEM guidance for avoiding vessel strikes.

An accidental diesel fuel spill adjacent to or within the North Atlantic right whale critical habitat during the winter calving period could result in the direct contact of the spilled fuel with both adults and calves. Based on the assumed small size of the spill and the likelihood that it would disperse and weather rapidly, it is likely that few individuals would be exposed and there would be no prolonged exposure for any animals. A small fuel spill would not be likely to result in the death or life-threatening injury of individual North Atlantic right whales, or the long-term displacement of these animals from their critical habitat or migratory routes.

5.9.2. Effects on Sea Turtles

The potential impacts of a small diesel spill (1.2-7.1 bbl) as evaluated for the proposed action could vary depending on the spill location and the meteorological and oceanographic conditions at the time. However, in general, a small spill would be expected to disperse quickly in the open ocean and would not be likely to contact more than a few individual sea turtles. Prolonged exposure would not be likely for any individuals in the open ocean. A small spill would be unlikely to result in the death or life-threatening injury of individual sea turtles, or the long-term displacement of sea turtles from preferred feeding, breeding, or nesting habitats or migratory routes. Therefore, potential impacts to listed sea turtles within the BA Area are expected to affect but not adversely affect listed sea turtles.

Effects of spilled oil on sea turtles are discussed by Geraci and St. Aubin (1987), Lutcavage et al. (1995, 1997), and Milton et al. (2003). Oil, including diesel fuel, may affect sea turtles through various pathways including direct contact, inhalation of the fuel and its volatile components, and ingestion (directly or indirectly through the consumption of fouled prey species) (Geraci and St. Aubin, 1987). Several aspects of sea turtle biology and behavior place them at risk, including lack of avoidance behavior, indiscriminate feeding in convergence zones, and inhalation of large volumes of air before dives (Milton et al., 2003). Studies have shown that direct exposure of sensitive tissues (e.g., eyes, nares, other mucous membranes) and soft tissues to diesel fuel or volatile hydrocarbons may produce irritation and inflammation. Diesel fuel can adhere to turtle skin or shells. Turtles surfacing within or near a diesel release would be expected to inhale petroleum vapors, causing respiratory stress. Ingested diesel fuel, particularly the lighter fractions, can be acutely toxic to sea turtles. The assumed small size and rapid dispersion of a spill in the open ocean are the main factors mitigating the potential for significant impacts on sea turtles.

5.9.3. Effects on Birds

The potential impacts of a small diesel spill (1.2-7.1 bbl) as evaluated for the proposed action could vary depending on the spill location and the meteorological and oceanographic conditions at the time. However, in general, a small spill would be expected to disperse quickly in the open ocean and would not be likely to contact more than a few individual birds. Prolonged exposure would not be likely for any individuals in the open ocean. A small spill would be unlikely to result in the death or life-threatening injury of individual birds, or the long-term displacement of birds from preferred feeding, breeding, or nesting habitats or migratory routes. Therefore, potential impacts to listed birds within the BA Area are expected to affect but not adversely affect listed birds.

In the event of a fuel spill, the marine and coastal bird species affected and the type of effect would differ depending on the location of the spill (Weise and Jones, 2001; Castege et al., 2007). A spill in offshore waters could affect seabirds such as the roseate tern and Bermuda petrel, but would be unlikely to affect shorebirds such as the piping plover or red knot. The roseate tern and Bermuda petrel could be exposed to diesel fuel floating on the sea surface. Direct contact with diesel fuel may result in the fouling or matting of feathers with subsequent limitation or loss of flight capability or insulating or water-repellent capabilities; irritation or inflammation of skin or sensitive tissues, such as eyes and other mucous membranes; or toxic effects from ingested diesel fuel or the inhalation of diesel and its volatile components. Birds coming in contact with spilled diesel could also suffer from chronic toxicity due to ingestion and/or absorption. Affected birds could also carry diesel fuel to nests where eggs and young could be exposed. Contamination of foraging habitat and prey items could also occur. However, the potential for significant effects would be limited because of the assumed small size and rapid dispersion of the spill, as well as the generally low densities of seabirds in offshore waters. A small spill in the open ocean would be expected to disperse quickly and would not be likely to contact more than a few individual seabirds. Prolonged exposure would not be likely for any individuals, and death or life-threatening injury of individual birds would be unlikely.

A spill in nearshore waters could affect any of the listed species, including shorebirds such as the piping plover and red knot. Direct and indirect impacts would be similar to those described above for an offshore spill, but with a greater potential for contamination of foraging habitats along the shoreline.

5.9.4. Effects on Fishes

The potential impacts of a small diesel spill (1.2-7.1 bbl) as evaluated for the proposed action could vary depending on the spill location and the meteorological and oceanographic conditions at the time. However, a small fuel spill is unlikely to affect any of the listed fish species in this analysis. Generally, eggs and larvae are the stages that are most sensitive to oiling; however, because of their life histories, none of the listed fish species included in the BA would have eggs or larvae in the water column of the BA Area where they could be exposed to a spill.

Effects of spilled oil on fishes have been studied extensively (Hose et al., 1996; Kocan et al., 1996; Carls et al., 1999; Couillard et al., 2005; Ramachandran, 2005; Schein et al., 2009). Schein et al. (2009) showed that the constituents of diesel remaining 18 hr after simulated weathering and solubilization were chronically toxic to rainbow trout. Additional studies have shown significant reduction in growth of embryos, a cessation of development, or both, as indicated by a smaller size and reduced absorption of yolk. Release and dissolution of spilled diesel may also decrease ambient oxygen concentrations in the water column.

As adults, the alewife and blueback herring feed in coastal and offshore waters and could be exposed to an oil spill in the water column. However, the potential for significant effects would be limited because of the assumed small size and rapid dispersion of the spill. A small spill in the open ocean would be expected to disperse quickly. Because of the schooling behavior of alewife and blueback herring, a spill could contact many individual fishes, but prolonged exposure would not be likely, and death or life-threatening injury of individual fishes would be unlikely.

As adults, three of the species (smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon) are demersal and are unlikely to be contacted by a diesel spill because it would be expected to float and disperse on the sea surface. There is the potential for a small proportion of the heavier fuel components to adhere to particulate matter in the upper portion of the water column and sink. However, due to the assumed small size of the spill, it is unlikely that benthic habitats would be contaminated to an extent that would significantly affect any of the demersal species.

5.10. Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Federal activities are covered in their own ESA Section 7 consultations and are not addressed as part of the cumulative scenario under the ESA. Cumulative effects can result from individually minor, but collectively significant, actions taking place over time. A relevant discussion of cumulative effects must account for past and current activities (the baseline) as well as future State or private activities. **Section 4** provides an overview of the environmental baseline in the BA Area, and **Section 3** describes the life history and status of protected species in detail. Impacts of the proposed action to protected species were evaluated previously in **Sections 5.1** through **5.9**.

5.10.1. Cumulative Activity Scenario

Future State or private activities that are reasonably certain to occur within the BA Area during the period of the proposed action include

- shipping and marine transportation;
- commercial and recreational fishing;
- operation of LNG import terminals;
- dredging and dredged material disposal; and
- coastal development.

Two other factors, climate change and ambient ocean noise, are also considered in the cumulative analysis.

5.10.1.1. Shipping and Marine Transportation

Shipping and marine transportation in the BA Area are discussed in **Section 4.1.1**. Deepwater commercial ports located along the coast adjacent to the BA Area include Norfolk, Virginia (Port of Virginia); Wilmington, North Carolina; Charleston, South Carolina; Savannah, Georgia; Brunswick, Georgia; and Jacksonville, Florida. In addition, Delaware Bay provides access to Delaware River ports and terminals in the Wilmington, Delaware, and Philadelphia, Pennsylvania, area. Chesapeake Bay provides access to the Port of Baltimore and numerous smaller ports in Maryland and Virginia.

Large commercial vessels (cargo ships, tankers, and container ships) use these ports to access overland rail and road routes to transport goods throughout the U.S. Other vessels using these ports include military vessels, commercial business craft (tug boats, fishing vessels, and ferries), commercial recreational craft (cruise ships and fishing/sight-seeing/diving charters), research vessels, and personal craft (fishing boats, houseboats, yachts and sailboats, and other pleasure craft).

Insight into the levels of shipping and marine transportation occurring along the U.S. Atlantic coast is offered by NOAA's analyses prepared for the North Atlantic right whale ship strike reduction effort (USDOC, NMFS, 2008). Vessel activity was classified as follows, based on USCG data for 2002-2004 and considering vessels of 150 gross registered tons or more:

- 25,532 vessel arrivals at U.S. east coast ports in 2003;
- Arrivals increased by 7.3 percent to 27,385 vessel arrivals in 2004;
- The largest number of vessel arrivals was recorded in the Ports of New York/New Jersey (5,426 vessel arrivals in 2003; 5,550 vessel arrivals in 2004), followed by the Chesapeake Bay region (4,486 vessel arrivals in 2003 and 4,875 vessel arrivals in 2004), which includes the ports of Baltimore, Norfolk, and Hampton Roads; and
- Other significant port regions with more than 2,000 vessel arrivals in 2004 include the southeastern U.S. (4,315 vessel arrivals), Delaware Bay (2,661 vessel arrivals), Block Island Sound (2,563 vessel arrivals), Savannah, Georgia (2,474 vessel arrivals), and Charleston, South Carolina (2,473 vessel arrivals).

Over the 2012-2020 time period of the Programmatic EIS, it is assumed that shipping and marine transportation activities in the BA Area will 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 will double its capacity (Canal de Panamá, 2012). Reasonably foreseeable IPFs associated with these activities include

- vessel traffic, including associated effluent discharges, air emissions, and noise;
- accidental releases of trash and marine debris; and
- a risk of fuel spills from commercial vessels.

5.10.1.2. Commercial and Recreational Fishing

Commercial and recreational fishing in the BA Area is summarized in **Section 4.1.2**. **Chapters 4.2.7** and **4.2.8** of the Programmatic EIS provide additional information about commercial and recreational fishing activities in the BA Area. Although there are interannual and seasonal variations in both types of activities, as well as geographic differences among states, there are no apparent long-term temporal trends in the level of these activities. Over the 2012-2020 time period of the Programmatic EIS, it is assumed that these activities will continue at about the present level. Reasonably foreseeable IPFs associated with commercial and recreational fishing include

- direct taking of fish and shellfish resources, including targeted species and bycatch;
- incidental taking of protected species;
- seafloor disturbance and turbidity due to trawling and dredging;
- vessel traffic, including the associated effluent discharges, air emissions, and noise;
- accidental releases of trash and marine debris (e.g., discarded fishing line); and
- a risk of fuel spills from commercial and recreational vessels.

5.10.1.3. Operation of Liquefied Natural Gas Import Terminals

There are two USCG/MARAD licensed deepwater ports offshore the Atlantic coast – Neptune and Northeast Gateway, both located offshore Massachusetts. There are no active, pending applications for deepwater ports on the Atlantic coast (USDHS, USCG, 2011a). There are three FERC-licensed LNG terminals in Atlantic states – Everett, Massachusetts; Cove Point, Maryland; and Elba Island, Georgia (FERC, 2012).

Because there are no active, pending deepwater port applications, the cumulative scenario assumes that no deepwater LNG port construction will occur within the BA Area during the 2012-2020 period. The development of shale gas in Appalachian Basin black shales has created a significant new source of onshore gas in proximity to major use areas along Atlantic coast states. Planning for LNG facilities, in general, has been complicated by this development, making it difficult to predict the level of future LNG port construction. However, over the 2012-2020 time period, it is reasonable to assume that no additional deepwater LNG port construction will occur. The main, reasonably foreseeable IPFs associated with routine operations of the existing LNG terminals are vessel traffic, along with the associated discharges; air emissions; and noise.

5.10.1.4. Dredging and Dredged Material Disposal

Dredged material disposal sites in the BA Area are discussed in **Section 4.1.9**. There are 13 designated dredged material disposal sites on the Atlantic OCS ranging from Dam Neck, Virginia, to Canaveral Harbor, Florida. The disposal sites are used mainly for the disposal of dredged material from the maintenance dredging of commercial ports. Typically, sites are permitted for continuing use, and the activity level varies depending on the dredging requirements for particular ports. Over the 2012-2020 time period of the Programmatic EIS, it is assumed that usage of dredged material disposal sites in the BA Area will continue at about the present level. Reasonably foreseeable IPFs associated with these activities include

- seafloor disturbance, turbidity, and benthic habitat alterations due to dredging (at the port or channel location) and dumping of dredged material (at the disposal site);
- a risk of direct physical impacts to sea turtles (e.g., by hopper dredges);
- vessel traffic and associated effluent discharges, air emissions, and noise;
- accidental releases of trash and marine debris; and
- a risk of fuel spills from dredging vessels.

5.10.1.5. Coastal Development

As discussed in **Section 4.1.10**, coastal development includes an array of human activities such as beachfront construction of homes, hotels, restaurants, roads, harbors, jetties, seawalls, and other forms of coastal armoring.

Over the 2012-2020 time period of the Programmatic EIS, it is assumed that coastal development will continue at about the present level. The BOEM anticipates that OCS sand resources will continue to be used for beach restoration and shoreline protection projects over the time period covered by the Programmatic EIS. Reasonably foreseeable IPFs associated with these activities include

- coastal habitat loss, fragmentation, and degradation due to development;
- direct impacts on beaches due to coastal restoration projects;
- increased lighting and noise due to development near beaches;
- increased runoff and pollutant loading in coastal waters;
- recreational vessel traffic and associated waste discharges and noise;
- accidental releases of trash and marine debris; and
- a risk of fuel spills from recreational vessels.

5.10.1.6. Climate Change

Warming of the earth's climate system is occurring, and most of the observed increases in global average temperatures since the mid-20th century are very likely due to the observed increase in anthropogenic greenhouse gas concentrations (Intergovernmental Panel on Climate Change [IPCC], 2007; U.S. Global Change Research Program, 2009). Globally, many environmental effects have been documented, including widespread changes in snow melt and ice extent; spatial changes in precipitation patterns; changes in the frequency of extreme weather events; changes in stream flow and runoff patterns in snow-fed rivers; warming of lakes and rivers, with effects on thermal structure and water quality; changes in the timing of spring events such as bird migration and egg-laying; poleward shifts in ranges of plant and animal species; and acidification of marine environments (Orr et al., 2005; IPCC, 2007; Nye et al., 2009). Documented changes in marine and freshwater biological systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and circulation. These include shifts in ranges and changes in algal, plankton, and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; and range changes and earlier fish migrations in rivers (IPCC, 2007).

The U.S. Global Change Research Program (2009) has summarized regional climate changes for the southeastern U.S. (including most of the states inshore of the BA Area). Since 1970, average annual temperature has risen approximately 2°F (1.1°C) and the number of freezing days has declined by 4-7 days per year. Average autumn precipitation has increased 30 percent since 1901. There has been an increase in heavy downpours in many parts of the region, while the percentage of the region experiencing moderate to severe drought increased over the past three decades. The area of moderate to severe spring and summer drought has increased by 12 percent and 14 percent, respectively, since the mid-1970's. Continuing changes in precipitation could affect the water quality and marine ecology of the BA Area by altering the quantity and quality of runoff into estuaries.

Over the next century, the IPCC (2007) projects that global temperature increases will cause significant global environmental changes, including reductions in snow cover and sea ice; more frequent extreme heat waves and heavy precipitation events; an increase in the intensity of tropical cyclones (hurricanes and typhoons); and numerous hydrological, ecological, social, and health effects. Regionally, the U.S. Global Change Research Program (2009) predicts similar long-term changes for the southeastern U.S., including increased shoreline erosion due to sea level rise and increases in hurricane intensity; a precipitous decline in wetland-dependent fish and shellfish populations due to loss of coastal marshes; heat-related stresses for people, plants, and animals; and decreased water availability due to increased temperature and longer time between rainfall events. The resilience of many ecosystems is likely to be exceeded by an unprecedented combination of climate change, associated disturbances, and other global change drivers. There are projected to be major changes in ecosystem structure and function, species' ecological interactions, and shifts in species' geographical ranges, with predominantly negative consequences for biodiversity and ecosystem function (IPCC, 2007).

Reasonably foreseeable marine environmental changes in the BA Area that could result from climate change over the next century include altered migratory routes and timing (e.g., for marine mammals and migratory birds); changes in shoreline configuration that could adversely affect sea turtle and shorebird and seabird nesting beaches and prompt increased levels of beach restoration activity (and increased use of OCS sand sources); changes in estuaries and coastal habitats due to interactive effects of climate change along with development and pollution; and impacts on calcification in plankton, corals, crustaceans, and other marine organisms due to ocean acidification (The Royal Society, 2005).

Over the next two decades, the IPCC (2007) projected a warming of about 0.2 °C per decade. During the 10-year time period of the Programmatic EIS (2012-2020), environmental changes in the BA Area due to climate change are likely to be small, incremental, and difficult to discern from effects of other natural and anthropogenic factors.

5.10.1.7. Ambient Ocean Noise

Various activities and processes, both natural and anthropogenic, combine to form the sound profile within the ocean, generally referred to as ambient ocean noise (Richardson et al., 1995; Hildebrand, 2009). Most ambient noise is broadband (composed of a spectrum of numerous frequencies without a differentiating pitch) and encompasses virtually the entire frequency spectrum. For purposes of understanding the sources and characteristics of ocean ambient noise, it can be divided into three frequency bands: low (10-500 Hz), medium (500 Hz-25 kHz), and high (>25 kHz) (Hildebrand, 2009). Shipping noise is the main contributor to ambient ocean noise in the low-frequency band (NRC, 2003; Hildebrand, 2009). Noise in the low-frequency band has a broad maximum around 10-80 Hz, with a steep negative slope above 80 Hz. According to ambient noise spectra presented by Hildebrand (2009), spectrum levels of ambient noise from shipping are 60-90 dB re 1 μPa^2 Hz^{-1}. Sea surface agitation correlated with wind and sea state are the major contributions to ambient noise in the medium frequency band. In the high-frequency band, "thermal noise" caused by the random motion of water molecules is the primary source (Hildebrand, 2009). Ambient noise sources, especially noise from wave and tidal action, can cause coastal environments to have particularly high ambient noise levels.

A large portion of the noise from vessel traffic comes from vessel engines and propellers, and those sounds occupy the low frequencies used by most large whales (Richardson et al., 1995). In the open water, ship traffic can influence ambient background noise at distances of thousands of kilometers; however, the effects of ship traffic sounds in shallow coastal waters are much less far reaching, most likely because a large portion of the sound's intensity is absorbed by soft, nonreflective, unconsolidated materials (sands and mud) on the seafloor. Other anthropogenic sources include dredging, oil and gas operations, nearshore construction activities, and sonar signals (especially those used by the military).

Behavioral responses of cetaceans to underwater noise and the population consequences of those responses are subjects of recent and ongoing research (NRC, 2005; Southall et al., 2007; Ellison et al., 2011). However, the increased noise may be steadily eroding marine mammals' abilities to communicate.

Acousticians have estimated that the chance of two whales hearing each other today has been reduced to 10 percent of what it was 100 years ago due to the masking of communication sounds by the ambient ocean noise created by multiple industrial activities (Parks and Clark, 2007). At some point this acoustic smog (Clark et al., 2007) could affect the abilities of whales to find food and mates. Because the bulk of human industrial sounds in the oceans are low frequency, it is likely that the large mysticete whales would be affected first. Fish can also use and communicate by sound, and increased noise could interfere with their foraging and reproductive behaviors (Vasconcelos et al., 2007; Codarin et al., 2009).

Long-term data analyzed by McDonald et al. (2006) offshore California show an increase in ambient noise of approximately 10-12 dB in the frequency range 30-50 Hz over a 40-year period, suggesting an average noise increase rate of 2.5-3 dB per decade. The authors attributed the change to increased levels of shipping traffic. While comparable long-term data for the BA Area have not been published, it is assumed that underwater noise from vessel traffic and other anthropogenic sources is increasing and will continue to increase incrementally over the time period of the Programmatic EIS (2012-2020).

5.10.2. Cumulative Effects on Listed Marine Mammals

This analysis considers the incremental and synergistic impacts of the proposed action in combination with similar impacts from the cumulative activity scenario as described above. **Table A-19** lists the IPFs associated with the proposed action and sources of similar impacts in the cumulative activity scenario.

In the proposed action, IPFs applicable to listed marine mammals are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. As described in the preceding analyses, the greatest potential impacts on listed marine mammals would be from active acoustic sound sources (especially airgun arrays) and vessel traffic (e.g., vessel strikes). Impacts of trash and debris are expected to be avoided by mitigation, and the other IPFs are not likely to adversely affect any listed marine mammal species.

Table A-19

Sources of Impact-Producing Factors in the Proposed Action and Cumulative Activity Scenario

Impact-Producing Factor	Proposed Action Sources	Cumulative Scenario Sources
Active Acoustic Sound Sources	• High-energy sound sources (airguns, boomer and chirp subbottom profilers, side-scan sonars, and multibeam depth sounders)	• Military sound sources (sonars, explosives) • Vessel noise (shipping and marine transportation, commercial and recreational fishing, military use, etc.) • Ambient ocean noise
Vessel and Equipment Noise	• All G&G vessel engines • Equipment noise (e.g., during drilling of COST wells)	• Vessel noise (shipping and marine transportation, commercial and recreational fishing, military use, etc.) • Military sound sources (sonars, explosives) • Ambient ocean noise
Vessel Traffic	• All G&G vessel surveys	• Shipping and marine transportation • Commercial and recreational fishing • Military use • Sand and gravel mining and beach restoration • Renewable energy development • Oil and gas exploration and development • Dredging and dredged material disposal • Coastal development
Aircraft Traffic and Noise	• Aeromagnetic surveys; helicopter support for COST well drilling	• Military and civilian use of airspace
Trash and Debris	• All G&G vessel surveys	• Same as vessel traffic above
Seafloor Disturbance	• Geotechnical sampling and testing • Certain deep penetration seismic surveys, CSEM and MT surveys • Drilling of COST wells and shallow test wells • Site characterization for renewable energy areas	• Commercial fishing (e.g., trawling, dredging) • Military use • Sand and gravel mining and beach restoration • Renewable energy development • Oil and gas exploration and development • Dredging and dredged material disposal
Drilling	• Drilling of COST wells and	• Drilling of exploration wells (if leasing occurs)

Discharges	shallow test wells	
Accidental Fuel Spills	• All G&G vessel surveys	• All vessel activities
Climate Change	• Greenhouse gas emissions from G&G survey vessels and aircraft	• Global greenhouse gas emissions

Abbreviations: COST = continental offshore stratigraphic test; CSEM = controlled source electromagnetic; MT = magnetotelluric.

The proposed action will contribute incrementally to the ambient noise environment in the BA Area. There are numerous other sources of underwater noise. These include vessel noise from many activities, including shipping and marine transportation, and commercial and recreational fishing. As noted in **Section 5.10.1.7**, long-term data suggest an average increase in underwater noise of 2.5-3 dB per decade, primarily attributable to shipping. Most impacts of increasing ambient noise are expected to be in the category of masking and behavioral responses, rather than death, injury, or threshold shifts. The biological significance of behavioral responses to underwater noise and the population consequences of those responses are not fully understood (NRC, 2005; Southall et al., 2007). The increased noise may be steadily eroding marine mammals' abilities to communicate. Acousticians have estimated that the chance of two whales hearing each other today has been reduced to 10 percent of what it was 100 years ago due to the masking of communication sounds by the ambient ocean noise created by multiple industrial activities (Parks and Clark, 2007). At some point this acoustic smog could affect the abilities of whales to find food and mates (Clark et al., 2007).

Vessel strikes are the other main source of cumulative impacts in the BA Area. The proposed action will contribute incrementally to the risk of vessel strikes. However, G&G vessel activities involve much less risk of vessel strikes than most shipping sources. Vessel strikes on North Atlantic right whales are expected to be avoided due to (1) compliance with the Right Whale Ship Strike Reduction Rule (50 CFR 224.105); (2) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (3) the typical slow speed of seismic vessels; (4) the fact that these vessels are towing active sound sources that are within the hearing range of the listed whales; and (5) the use of protected species observers to scan the sea surface around seismic survey vessels.

5.10.3. Cumulative Effects on Listed Sea Turtles

Table A-19 lists the IPFs associated with the proposed action and sources of similar impacts in the cumulative activity scenario. In the proposed action, IPFs applicable to listed sea turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. As described in the preceding analyses, the greatest potential impacts on sea turtles are from active acoustic sound sources (especially airgun arrays) and vessel traffic (e.g., vessel strikes). Impacts of trash and debris are expected to be avoided by mitigation, and the other IPFs are not likely to adversely affect any sea turtle species.

The proposed action will contribute incrementally to the ambient noise environment in the BA Area. There are numerous other sources of underwater noise. These include vessel noise from many activities, including shipping and marine transportation, and commercial and recreational fishing. As noted in **Section 5.10.1.7**, long-term data suggest an average increase in underwater noise of 2.5 to 3 dB per decade, primarily attributable to shipping.

As discussed in **Section 5.2.2**, few studies have examined the role acoustic cues play in the ecology of sea turtles and little is known about the extent to which they use their auditory environment. However, impacts of increasing ambient noise would be expected to be in the category of behavioral responses and possibly masking effects, rather than death, injury, or threshold shifts. Avoidance responses to seismic signals have been observed, so it is known they can detect and respond to low-frequency sound. Sea turtles appear to be low frequency specialists, and thus the potential masking noises would fall within at least 50-1,000 Hz. However, there are no quantitative data demonstrating masking effects for sea turtles, and no noise exposure criteria have been developed for them.

Vessel strikes are the other main source of cumulative impacts in the BA Area. The proposed action will contribute incrementally to the risk of vessel strikes on sea turtles. However, G&G vessel activities involve much less risk of vessel strikes than most shipping sources. Vessel strikes on sea turtles are expected to be avoided due to (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels.

5.10.4. Cumulative Effects on Listed Birds

Table A-19 lists the IPFs associated with the proposed action and sources of similar impacts in the cumulative activity scenario. In the proposed action, IPFs applicable to listed bird species are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. As described in the preceding analyses, none of these sources are likely to have adverse effects on the species evaluated in the BA (roseate tern, Bermuda petrel, piping plover, and red knot). Active acoustic sound sources, vessel and equipment noise, and vessel traffic are expected to have no effects on the two coastal species (piping plover and red knot), and impacts on the two seabirds (roseate tern and Bermuda petrel) are not expected to be adverse. Aircraft traffic and noise could affect any of the bird species, but impacts are not expected to be adverse. Most impacts of trash and debris are expected to be avoided by mitigation, and a small, accidental fuel spill is not likely to result in adverse effects on any of the bird species analyzed.

The most important sources of cumulative impacts on listed birds include habitat loss and marine pollution due to coastal development, and habitat alteration due to global climate change. The proposed action is not a significant contributor to either of these impact sources.

5.10.5. Cumulative Effects on Listed Fishes

Table A-19 lists the IPFs associated with the proposed action and sources of similar impacts in the cumulative activity scenario. In the proposed action, IPFs applicable to listed fishes are active acoustic sound sources, trash and debris, seafloor disturbance, drilling discharges, and accidental fuel spills. As described in the preceding analyses, the greatest potential impacts on fishes are from active acoustic sound sources (particularly from airgun arrays). Seafloor disturbance and drilling discharges are not expected to result in impacts because of their limited areal extent. Impacts of trash and debris are expected to be avoided by mitigation, and a small, accidental fuel spill is not likely to adversely affect any of the listed fish species.

The proposed action would contribute incrementally to the ambient noise environment in the BA Area. There are numerous other sources of underwater noise. These include vessel noise from many activities, including shipping and marine transportation, and commercial and recreational fishing. As noted in **Section 5.10.1.7**, long-term data suggest an average increase in underwater noise of 2.5-3 dB per decade, primarily attributable to shipping.

Sound plays a major role in the lives of all fishes. In addition to listening to the overall environment and being able to detect sounds of biological relevance, many species of bony fishes communicate with sounds and use sounds in a wide range of behaviors. Consequently, anything that impedes the ability of fishes to hear biologically relevant sounds, such as those produced by anthropogenic sound sources, could interfere with the normal behaviors and even the survival of individuals, populations, or a species. Detailed discussions of fish bioacoustics can be found in the papers in Webb et al. (2008) and in papers by Fay and Megela-Simmons (1999), Zelick et al. (1999), and Popper et al. (2003). A broad discussion of interactions of anthropogenic sounds and fishes can be found in Popper and Hastings (2009a,b) and in the papers in Popper and Hawkins (2011). Impacts of increasing ambient noise on fishes would be expected to be in the category of masking and behavioral responses, rather than death, injury, or threshold shifts.

Seafloor disturbance and drilling discharges during the proposed action would directly affect small areas of benthic habitat, including areas potentially inhabited by three of the species included in the BA (smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon), but any effects are not expected to be adverse. However, the extent of seafloor disturbance in the proposed action represents a negligible percentage of the BA Area, and no adverse impacts on smalltooth sawfish, shortnose sturgeon, or Atlantic sturgeon are expected. Other sources of seafloor disturbance in the cumulative scenario include commercial fishing (trawling and dredging), and dredging and dredged material disposal. The proposed action would be a negligible source of seafloor disturbance in relation to these other activities.

All vessel activity included in the cumulative scenario carries a risk of accidental spills. Potential sources would include shipping and marine transportation, as well as commercial and recreational fishing vessels. A small, accidental fuel spill such as the one analyzed under the proposed action is not likely to result in effects on any of the listed fish species analyzed. The proposed action would be a negligible source of spill risk in relation to these other activities. The greatest risk of a fuel spill is to fishes at various life stages that occur near or at the surface. Direct exposure would only occur in the water column near the discharge point, thus pelagic adults and planktonic eggs and larvae are most susceptible. Smalltooth sawfish, shortnose sturgeon, and Atlantic sturgeon do not have pelagic life stages in waters of the BA Area, while blueback herring and alewife are anadromous (with spawing occurring in freshwater reaches of coastal rivers); therefore, the expected impact of an accidental diesel fuel spill is not expected to be adverse for any of the five species.

6. EFFECTS DETERMINATION FOR LISTED SPECIES AND DESIGNATED CRITICAL HABITATS

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with and with the assistance of NMFS and FWS as appropriate, to insure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat.

Table A-20 summarizes the effects determinations for the listed marine mammals, sea turtles, birds, and fishes present within the BA Area. Determinations for each species are discussed below in individual sections. There are three conclusions that an action agency may make based on their analyses of direct and indirect effects when determining whether formal consultation is necessary, based on the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998):

- **No Effect**. This is the appropriate determination when the action agency determines its proposed action is not expected to affect listed/proposed species or designated/proposed critical habitat;
- **May Affect, but Not Likely to Adversely Affect**. This is the appropriate determination when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are positive effects without any adverse effects. Insignificant effects relate to the size of the impact; the impact cannot be meaningfully detected, measured, or evaluated, and should never reach the scale where take occurs. Discountable effects are those that are extremely unlikely to occur; and
- **May Affect, Likely to Adversely Affect**. This is the appropriate determination when adverse effects that are not beneficial, insignificant, or discountable are likely to occur to listed species/critical habitat.

For species with designated or proposed critical habitat, the determination is made as to whether the proposed action would be likely to destroy or adversely modify the critical habitat.

6.1. MARINE MAMMALS

6.1.1. North Atlantic Right Whale

North Atlantic right whales could occur anywhere within the BA Area, and given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

However, the most likely known locations for right whales are within the winter calving and nursery grounds offshore Florida, Georgia, and South Carolina, and the migratory corridor between these winter grounds and the summer feeding grounds (**Figures A-4** and **A-5**). The proposed action includes a time-area closure that would effectively avoid these areas during the seasons when right whales are most likely to be present (see **Section 7.1.1**). Under the time-area closure, no airgun surveys would be authorized within the designated right whale critical habitat from November 15 through April 15 nor within the Mid-Atlantic and Southeast U.S. SMAs during the times when vessel speed restrictions are in effect under 50 CFR 224.105 (**Figure A-23**). However, HRG surveys proposed in the critical habitat and SMAs may be considered on a case-by-case basis if they use acoustic sources other than airguns. Any such authorization may include additional mitigation and monitoring requirements to avoid or significantly reduce impacts on right whales and would be subject to further NEPA and ESA review. Other supporting surveys (e.g., biological surveys) would not be affected by this restriction. Exceptions to the time-area closure could occur if a survey was needed to serve important operational or monitoring requirements for a particular project.

Table A-20

Summary of Effects Determinations for Listed Species and Critical Habitat

Common Name	ESA Status[1]	Effect Determination for Listed Species: No Effect	May Affect, but Not Likely to Adversely Affect	May Affect, Likely to Adversely Affect	Critical Habitat Determination
Marine Mammals					
North Atlantic Right Whale	E	--	--	X	No destruction or adverse modification of critical habitat. Southeastern U.S. critical habitat is within the BA area, but G&G activities would not destroy or adversely modify these areas.
Blue Whale	E	--	--	X	N/A (no critical habitat designated)
Fin Whale	E	--	--	X	N/A (no critical habitat designated)
Sei Whale	E	--	--	X	N/A (no critical habitat designated)
Humpback Whale	E	--	--	X	N/A (no critical habitat designated)
Sperm Whale	E	--	--	X	N/A (no critical habitat designated)
Florida Manatee	E	--	X	--	No destruction or adverse modification of critical habitat. Critical habitat is adjacent to the BA area, but G&G activities would not occur there and would not destroy or adversely modify these areas.
Sea Turtles					
Loggerhead Turtle	T	--	--	X	N/A (no critical habitat designated)
Green Turtle	T/E	--	--	X	No destruction or adverse modification of critical habitat. Critical habitat has been designated (in Puerto Rico) but is remote from the BA area and would not be affected.
Hawksbill Turtle	E	--	--	X	No destruction or adverse modification of critical habitat. Critical habitat has been designated (in Puerto Rico) but is remote from the BA area and would not be affected.
Kemp's Ridley Turtle	E	--	--	X	N/A (no critical habitat designated)
Leatherback Turtle	E	--	--	X	No effect (no critical habitat in BA area)
Birds					
Roseate Tern	E	--	X	--	N/A (no critical habitat designated)
Bermuda Petrel	E	--	X	--	N/A (no critical habitat designated)
Piping Plover	T	X	--	--	No destruction or adverse modification of critical habitat. Critical habitat exists along shorelines adjacent to the BA area, but G&G activities would not occur there and would not destroy or adversely modify these areas.
Red Knot	C	X	--	--	N/A (no critical habitat designated)
Fishes					
Smalltooth Sawfish	E	--	X	--	No destruction or adverse modification of critical habitat. Critical habitat has been designated (in south Florida) but is remote from the BA area and would not be affected.
Shortnose Sturgeon	E	--	X	--	N/A (no critical habitat designated)
Atlantic Sturgeon	E/T	--	X	--	N/A (no critical habitat designated)
Alewife	C	--	X	--	N/A (no critical habitat designated)
Blueback Herring	C	--	X	--	N/A (no critical habitat designated)

[1] ESA = Endangered Species Act (E = endangered; T = threatened; C = candidate).

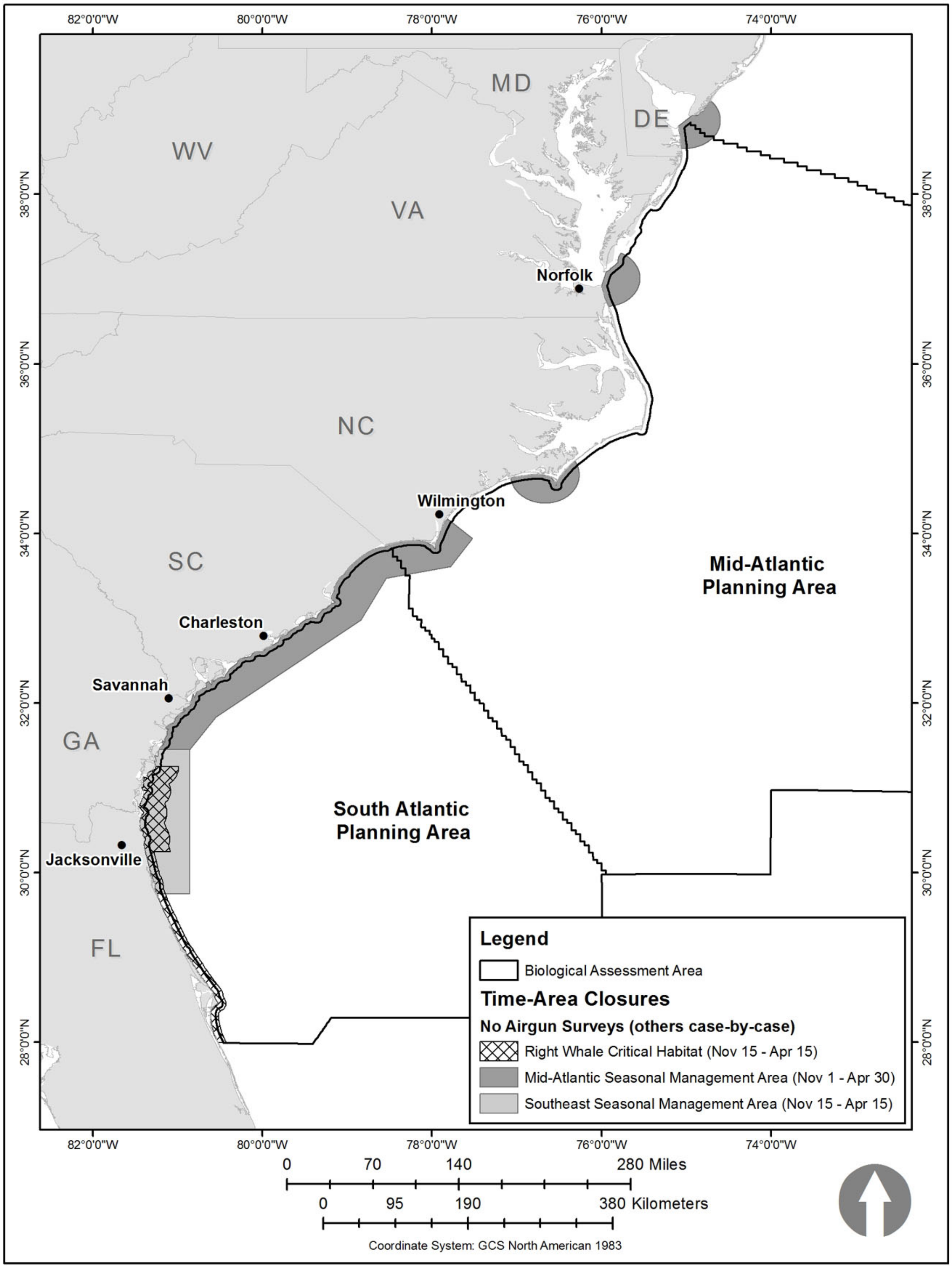


Figure A-23. Time-Area Closures Included in the Proposed Action.

Based on the analysis in **Section 5**, IPFs that potentially may affect North Atlantic right whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of North Atlantic right whales by active acoustic sound sources to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in Level B harassment of North Atlantic right whales. The mitigation measures during seismic airgun surveys would not prevent this impact. However, it is expected that the impacts would be avoided to the maximum extent practicable because of the time-area closures included in the proposed action.
- Vessel and equipment noise and aircraft traffic may elicit behavioral responses from North Atlantic right whales; any effects are expected to be minor. It is expected that the impacts would be avoided to the maximum extent practicable because of the time-area closures included in the proposed action.
- Vessel strikes on North Atlantic right whales are expected to be avoided because of (1) compliance with the Right Whale Ship Strike Reduction Rule (50 CFR 224.105); (2) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (3) the typical slow speed of seismic vessels; (4) the fact that these vessels are towing active sound sources that are within the hearing range of right whales; and (5) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on North Atlantic right whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adverselyaffect North Atlantic right whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some North Atlantic right whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

The proposed action is not expected to result in the destruction or adverse modification of right whale critical habitat given the very limited anticipated activity in critical habitat.

6.1.2. Blue Whale

Based on the species description in **Section 3**, the blue whale is an occasional visitor in the BA Area. However, given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect blue whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of blue whales to the maximum extent practicable. No mortalities or injuries are expected.

- Underwater noise, particularly from airguns, may result in Level B harassment of blue whales. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from blue whales; any effects are expected to be minor.
- Vessel strikes on blue whales are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of blue whales; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on blue whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect blue whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some blue whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the blue whale, and therefore no critical habitat determination is needed.

6.1.3. Fin Whale

Based on the species description in **Section 3**, the fin whale is probably the most common listed whale species within the BA Area. Given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect fin whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of fin whales to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in Level B harassment of fin whales. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from fin whales; any effects are expected to be minor.
- Vessel strikes on fin whales are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of fin whales; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be

released into the marine environment. Therefore, debris entanglement and ingestion impacts on fin whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect fin whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some fin whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the fin whale, and therefore no critical habitat determination is needed.

6.1.4. Sei Whale

Based on the species description in **Section 3**, the sei whale is likely to occur within the BA Area. Given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect sei whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of sei whales to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in Level B harassment of sei whales. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sei whales; any effects are expected to be minor.
- Vessel strikes on sei whales are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of sei whales; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on sei whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect sei whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some sei whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the sei whale, and therefore no critical habitat determination is needed.

6.1.5. Humpback Whale

Based on the species description in **Section 3**, the humpback whale is likely to occur within the BA Area. Reported sightings off Delaware Bay and Chesapeake Bay suggest that the Mid-Atlantic region may serve as wintering grounds for some humpback whales and possibly as an important area for juvenile humpbacks. Given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect humpback whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of humpback whales to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in Level B harassment of humpback whales. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from humpback whales; any effects are expected to be minor.
- Vessel strikes on humpback whales are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of humpback whales; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on humpback whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect humpback whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some humpback whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the humpback whale, and therefore no critical habitat determination is needed.

6.1.6. Sperm Whale

Based on the species description in **Section 3**, sperm whales are likely to occur within the BA Area. Given the geographic scope of the proposed action, these whales could reasonably be expected to come into contact with G&G survey activities. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect sperm whales are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding Level A harassment of sperm whales to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in Level B harassment of sperm whales. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sperm whales; any effects are expected to be minor.
- Vessel strikes on sperm whales are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of sperm whales; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on sperm whales are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect sperm whales.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in the incidental take of some sperm whales within the BA Area. Based on modeling calculations, it is likely that some Level B incidental takes would occur. Level A incidental takes may also occur if the mitigation measures included in the proposed action are not 100 percent effective. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the sperm whale, and therefore no critical habitat determination is needed.

6.1.7. Florida Manatee

Based on the species description in **Section 3**, the Florida subspecies of the West Indian manatee occurs mainly in coastal marine, brackish, and freshwater areas from Florida to Virginia. The BA Area includes Federal (OCS) waters of the Mid-Atlantic and South Atlantic Planning Areas. Given the geographic scope of the proposed action, it is possible, though unlikely, that manatees could be present in areas where G&G survey activities would occur (including vessel traffic between onshore support bases and offshore survey areas). Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect the Florida manatee are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Manatees are not likely to be present in or near waters where seismic airgun surveys would be conducted. In the event that any are present, mitigation measures including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements are expected to be effective in avoiding Level A harassment of manatees. In addition, it is unlikely that manatees would be exposed to underwater noise from seismic airgun surveys at levels sufficient to cause Level B harassment.
- Vessel and equipment noise, and aircraft traffic and noise are unlikely to affect manatees because most G&G activities would occur in offshore waters away from their preferred coastal habitats.
- Vessel strikes on manatees are expected to be avoided because most G&G activities would occur in offshore waters away from their preferred coastal habitats. Other mitigating factors include (1) the guidelines for vessel strike avoidance that would be

part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; (3) the fact that these vessels are towing active sound sources that are within the hearing range of manatees; and (4) the use of protected species observers to scan the sea surface around seismic survey vessels.

- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on manatees are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect manatees.

Based on the preceding analysis, the proposed action is not likely to result in incidental takes of Florida manatees. The modeling calculations predict no Level A or Level B takes of manatees. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated), and therefore the appropriate determination is **May Affect, but Not Likely to Adversely Affect**.

Critical habitat for the Florida manatee includes inland waterways in four northeastern Florida coastal counties (Brevard, Duval, St. Johns, and Nassau) that are inshore of the BA Area (**Figure A-10**). However, no G&G activities are proposed within these areas, and no destruction or adverse modification of critical habitat is expected.

6.2. SEA TURTLES

6.2.1. Loggerhead Turtle

Based on the species description in **Section 3**, loggerhead turtles commonly occur within the BA Area, parts of which are near globally significant nesting beaches in Florida. Given the geographic scope of the proposed action, loggerhead turtles could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect loggerhead turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding injury to loggerhead turtles to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in behavioral disturbance of loggerhead turtles. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sea turtles; any effects are expected to be minor.
- Vessel strikes on sea turtles are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on loggerhead turtles are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect loggerhead turtles.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in behavioral disturbance of and potential auditory injuries to some loggerhead turtles within the BA Area. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the loggerhead turtle, and therefore no critical habitat determination is needed.

6.2.2. Green Turtle

Based on the species description in **Section 3**, green turtles commonly occur within the BA Area, parts of which are near globally significant nesting beaches in Florida. Given the geographic scope of the proposed action, green turtles could reasonably be expected to come into contact with G&G survey activities. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect green turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding injury to green turtles to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in behavioral disturbance of green turtles. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sea turtles; any effects are expected to be minor.
- Vessel strikes on sea turtles are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on green turtles are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect green turtles.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in behavioral disturbance of and potential auditory injuries to some green turtles within the BA Area. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

Designated critical habitat for the green turtle is located in Puerto Rico and would not be affected by the proposed action.

6.2.3. Hawksbill Turtle

Based on the species description in **Section 3**, hawksbill turtles may occur within the BA Area, although they are rarely reported north of Florida. Given the geographic scope of the proposed action, hawksbill turtles could reasonably be expected to come into contact with G&G survey activities. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect hawksbill turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding injury to hawksbill turtles to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in behavioral disturbance of hawksbill turtles. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sea turtles; any effects are expected to be minor.
- Vessel strikes on sea turtles are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on hawksbill turtles are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect hawksbill turtles.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in behavioral disturbance of and potential auditory injuries to some hawksbill turtles within the BA Area. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

Designated critical habitat for the hawksbill turtle is located in Puerto Rico and would not be affected by the proposed action.

6.2.4. Kemp's Ridley Turtle

Based on the species description in **Section 3**, Kemp's ridley turtles may occur within the BA Area, but are probably the least abundant sea turtle there. Given the geographic scope of the proposed action, Kemp's ridley turtles could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect Kemp's ridley turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding injury to Kemp's ridley turtles to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in behavioral disturbance of Kemp's ridley turtles. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sea turtles; any effects are expected to be minor.
- Vessel strikes on sea turtles are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and

(3) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on Kemp's ridley turtles are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect Kemp's ridley turtles.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in behavioral disturbance of and potential auditory injuries to some Kemp's ridley turtles within the BA Area. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the Kemp's ridley turtle, and therefore no critical habitat determination is needed.

6.2.5. Leatherback Turtle

Based on the species description in **Section 3**, leatherback turtles are likely to be found throughout the BA Area. Given the geographic scope of the proposed action, leatherback turtles could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect leatherback turtles are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Mitigation measures in place during seismic airgun surveys, including ramp-up, visual monitoring of an exclusion zone, and shutdown requirements, are expected to be effective in avoiding injury to leatherback turtles to the maximum extent practicable. No mortalities or injuries are expected.
- Underwater noise, particularly from airguns, may result in behavioral disturbance of leatherback turtles. The mitigation measures during seismic airgun surveys would not prevent this impact.
- Vessel and equipment noise and aircraft traffic and noise may elicit behavioral responses from sea turtles; any effects are expected to be minor.
- Vessel strikes on sea turtles are expected to be avoided because of (1) the guidelines for vessel strike avoidance that would be part of all authorizations for shipboard surveys under the proposed action; (2) the typical slow speed of seismic vessels; and (3) the use of protected species observers to scan the sea surface around seismic survey vessels.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on leatherback turtles are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect leatherback turtles.

Based on the preceding analysis, the overall effect of the proposed action is likely to result in behavioral disturbance of and potential auditory injuries to some leatherback turtles within the BA Area. According to the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), if any incidental taking is anticipated to occur as a result of a proposed action and the effects are not discountable (extremely unlikely to occur), the appropriate determination is **May Affect, Likely to Adversely Affect**.

There is no designated critical habitat for the leatherback turtle, and therefore no critical habitat determination is needed.

6.3. Birds

6.3.1. Roseate Tern

Based on the species description in **Section 3**, roseate terns are likely to be found within the BA Area, although they are primarily found farther north. Given the geographic scope of the proposed action, they could reasonably be expected to come into contact with G&G survey activities. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect roseate terns are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources and vessel and equipment noise are likely to have no detectable effect on roseate terns. Roseate terns forage offshore and feed by plunge-diving, often submerging completely when diving for fish. However, with air-adapted ears, seabirds are not believed to be particularly sensitive to underwater sound (Dooling and Popper, 2000). Given the typical low density of seabirds offshore, it is expected that few if any roseate terns would be exposed to underwater noise other than on an occasional basis.
- Vessel and equipment noise, vessel traffic, and aircraft traffic and noise may result in minor disturbance to roseate terns, but no significant adverse effects.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on roseate terns are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect roseate terns.

Based on the preceding analysis, effects on the roseate tern would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated), and therefore the appropriate determination is **May Affect, but Not Likely to Adversely Affect**.

There is no designated critical habitat for the roseate tern, and therefore no critical habitat determination is needed.

6.3.2. Bermuda Petrel

Based on the species description in **Section 3**, Bermuda petrels are likely to be found within the BA Area. Although their distribution during non-breeding seasons is not well known, they are presumed to be widespread throughout the North Atlantic, following the warm waters on the western edges of the Gulf Stream. Bermuda petrels that come into the BA Area could reasonably be expected to come into contact with G&G activities since they forage offshore and feed at or near the surface. Therefore, a "No Effect" determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect Bermuda petrels are active acoustic sound sources, vessel and equipment noise, vessel traffic, aircraft traffic and noise, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources and vessel and equipment noise are likely to have no detectable effect on Bermuda petrels. They feed by snatching food or "dipping," or by scavenging dead or dying prey floating on or near the sea surface. Therefore, they are unlikely to be exposed to high levels of underwater noise from airguns. Also, with air-adapted ears, seabirds are not believed to be particularly sensitive to underwater sound (Dooling and Popper, 2000). Given the typical low density of seabirds offshore, it is likely that few if any Bermuda petrels would be exposed to underwater noise other than on an occasional basis.

- Vessel and equipment noise, vessel traffic, and aircraft traffic and noise may result in minor disturbance to Bermuda petrels, but no significant adverse effects. Breeding areas in Bermuda are remote from the vessel traffic included in the proposed action.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on Bermuda petrels are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect Bermuda petrels.

Based on the preceding analysis, effects on the Bermuda petrel would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated), and therefore the appropriate determination is **May Affect, but Not Likely to Adversely Affect**.

There is no designated critical habitat for the Bermuda petrel, and therefore no critical habitat determination is needed.

6.3.3. Piping Plover

Based on the species description in **Section 3**, piping plovers are found primarily along shorelines of the BA Area, especially sandy beaches and mudflats. Piping plovers do not feed offshore and are unlikely to come into contact with G&G survey activities.

Based on the analysis in **Section 5**, the only IPFs that potentially may affect piping plovers are trash and debris and accidental fuel spills. Potential impacts are summarized as follows:

- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on piping plovers are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect piping plovers.

Based on the preceding analysis, the proposed action is expected to have **No Effect** on the piping plover. The effects of the proposed action are spatially separated from the species distribution such that no impacts are expected.

Critical habitat exists along shorelines adjacent to the BA Area, including North Carolina, South Carolina, Georgia, and Florida. However, G&G activities would not occur there or affect these areas. No destruction or adverse modification of critical habitat is expected.

6.3.4. Red Knot

Based on the species description in **Section 3**, red knots are found primarily along shorelines of the BA Area. They migrate in large flocks between breeding grounds in mid- and high-Arctic areas and wintering grounds in southern South America. Along the Mid-Atlantic and southeastern coasts, red knots forage along sandy beaches, tidal mudflats, salt marshes, and peat banks. Approximately 90 percent of the entire population can be found in Delaware Bay on one day, feeding primarily on horseshoe crab eggs (USDOI, FWS, 2010a).

Red knots do not feed offshore and are unlikely to come into contact with G&G survey activities. Based on the analysis in **Section 5**, the only IPFs potentially affecting red knots are trash and debris and accidental fuel spills. Potential impacts are summarized as follows:

- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on red knots are expected to be avoided.

- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to adversely affect red knots.

Based on the preceding analysis, the proposed action is expected to have **No Effect** on the red knot. The effects of the proposed action are spatially separated from the species distribution such that no impacts are expected. There is no designated critical habitat for this candidate species, and therefore no critical habitat determination is needed.

6.4. FISHES

6.4.1. Smalltooth Sawfish

Based on the species description in **Section 3**, the smalltooth sawfish rarely occurs within the BA Area, with only two documented occurrences in recent years. The smalltooth sawfish normally inhabits shallow waters (10 m [33 ft] or less), often near river mouths or in estuarine lagoons over sandy or muddy substrates, but may also occur in deeper waters (~70 m [230 ft]) of the continental shelf. Given the geographic scope of the proposed action, they could (although unlikely) come into contact with G&G survey activities, particularly offshore Florida. Therefore, a “No Effect” determination is not appropriate for this species.

Based on the analysis in **Section 5**, IPFs that potentially may affect smalltooth sawfish are active acoustic sound sources, seafloor disturbance, drilling discharges, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources are unlikely to have any adverse effects on smalltooth sawfish.
- Seafloor disturbance and drilling discharges (if any) are expected to have no detectable effects on smalltooth sawfish. Although the species inhabits soft bottom areas, the extent of seafloor disturbance from all of the G&G activities in the proposed action, including accumulation of drilling discharges, is a negligible percentage of the available soft bottom habitat in the BA Area. Given the limited extent of seafloor disturbance in the proposed action, it is unlikely that this species would come into contact with affected areas.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on smalltooth sawfish are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to reach the benthic environment where smalltooth sawfish live.

Based on the preceding analysis, the proposed action **May Affect, but is Not Likely to Adversely Affect**, the smalltooth sawfish. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated).

Critical habitat has been designated in southern Florida but is remote from the BA Area, and G&G activities would not occur there or affect these areas. Therefore, no destruction or adverse modification of critical habitat is expected.

6.4.2. Shortnose Sturgeon

Based on the species description in **Section 3**, the shortnose sturgeon is primarily an estuarine and riverine species that rarely enters the coastal ocean of the BA Area. Shortnose sturgeon have rarely been found in coastal or shelf waters. Therefore, it is unlikely they would come into contact with G&G activities.

Based on the analysis in **Section 5**, IPFs that potentially may affect shortnose sturgeon are active acoustic sound sources, seafloor disturbance, drilling discharges, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources are unlikely to have adverse effects on shortnose sturgeon.
- Seafloor disturbance and drilling discharges (if any) are expected to have no detectable effects on shortnose sturgeon. Although the species inhabits soft bottom areas, the extent of seafloor disturbance from all of the G&G activities in the proposed action, including accumulation of drilling discharges, is a negligible percentage of the available soft bottom habitat in the BA Area. Given the limited extent of seafloor disturbance in the proposed action, it is unlikely that this species would come into contact with affected areas.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on shortnose sturgeon are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to reach the benthic environment where shortnose sturgeon live.

Based on the preceding analysis, the proposed action **May Affect, but is Not Likely to Adversely Affect**, the shortnose sturgeon. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated).

There is no designated critical habitat for the shortnose sturgeon, and therefore no critical habitat determination is needed.

6.4.3. Atlantic Sturgeon

Based on the species description in **Section 3**, the Atlantic sturgeon occurs within the BA Area. Areas of particular concentration have been identified in water depths between 9.1 and 21.3 m (30 and 70 ft) offshore Virginia and near sand shoals adjacent to Oregon Inlet, North Carolina (Laney et al., 2007). The Atlantic sturgeon uses estuarine and marine waters primarily during fall and winter months, then ascends the spawning rivers from March-April. Given the geographic scope of the proposed action, they could reasonably be expected to come into contact with G&G survey activities.

Based on the analysis in **Section 5**, IPFs that potentially may affect Atlantic sturgeon are active acoustic sound sources, seafloor disturbance, drilling discharges, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources are unlikely to have adverse effects on Atlantic sturgeon.
- Seafloor disturbance and drilling discharges (if any) are expected to have no detectable effects on Atlantic sturgeon. Although the species inhabits soft bottom areas, the extent of seafloor disturbance from all of the G&G activities in the proposed action, including accumulation of drilling discharges, is a negligible percentage of the available soft bottom habitat in the BA Area. Given the limited extent of seafloor disturbance in the proposed action, it is unlikely that this species would come into contact with affected areas.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on Atlantic sturgeon are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean and is unlikely to reach the benthic environment where Atlantic sturgeon live.

Based on the preceding analysis, the proposed action **May Affect, but is Not Likely to Adversely Affect**, the Atlantic sturgeon. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated).

No critical habitat has been designated for the Atlantic sturgeon, and therefore no critical habitat determination is needed.

6.4.4. Alewife

Based on the species description in **Section 3**, the alewife occurs within the AOI. The alewife uses estuarine and marine waters primarily during fall and winter, then ascends the spawning rivers from March-April. Given the geographic scope of the proposed action, adult populations could reasonably be expected to come into contact with G&G survey activities.

Based on the analysis in **Section 5**, IPFs that potentially may affect the alewife are active acoustic sound sources, seafloor disturbance, drilling discharges, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources such as airguns are unlikely to have adverse effects on alewives.
- Seafloor disturbance and drilling discharges (if any) are expected to have no detectable effects on the alewife. This species inhabits and feeds in the water column, and therefore seafloor disturbance would not affect its normal activities. Drilling discharges would affect a negligible percentage of the water column in the BA Area. Given the limited extent of drilling discharges projected for the proposed action, it is unlikely that this species would come into contact with affected areas.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be released into the marine environment. Therefore, debris entanglement and ingestion impacts on the alewife are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean but would temporarily affect the water column where alewives live.

Based on the preceding analysis, the proposed action **May Affect, but is Not Likely to Adversely Affect**, the alewife. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated).

No critical habitat has been designated for this proposed species, and therefore no critical habitat determination is needed.

6.4.5. Blueback Herring

Based on the species description in **Section 3**, the blueback herring occurs within the AOI. The blueback herring uses estuarine and marine waters primarily during fall and winter, then ascends the spawning rivers from March-May. Given the geographic scope of the proposed action, adult populations could reasonably be expected to come into contact with G&G survey activities.

Based on the analysis in **Section 5**, IPFs that potentially may affect the blueback herring are active acoustic sound sources, seafloor disturbance, drilling discharges, trash and debris, and accidental fuel spills. Potential impacts are summarized as follows:

- Active acoustic sound sources are unlikely to have adverse effects on blueback herring.
- Seafloor disturbance and drilling discharges (if any) are expected to have no detectable effects on the blueback herring. This species inhabits and feeds in the water column, and therefore seafloor disturbance would not affect its normal activities. Drilling discharges would affect a negligible percentage of the water column in the BA Area. Given the limited extent of drilling discharges projected for the proposed action and the temporary nature of elevated turbidity, it is unlikely that this species would come into contact with affected areas of the water column.
- Taking into account the USCG and USEPA regulations and BOEM guidance, it is unlikely that significant amounts of trash and debris from G&G activities will be

released into the marine environment. Therefore, debris entanglement and ingestion impacts on the blueback herring are expected to be avoided.
- A small, accidental diesel fuel spill from a G&G survey vessel would be expected to disperse quickly in the open ocean but would only temporarily affect the water column where river herirng live.

Based on the preceding analysis, the proposed action **May Affect, but is Not Likely to Adversely Affect**, the blueback herring. Based on the terminology used in the Endangered Species Consultation Handbook (USDOI, FWS and USDOC, NMFS, 1998), effects would be discountable (extremely unlikely to occur) and/or insignificant (the impact cannot be meaningfully detected, measured, or evaluated).

No critical habitat has been designated for this candidate species, and therefore no critical habitat determination is needed.

7. MITIGATION, MONITORING, AND REPORTING REQUIREMENTS FOR LISTED SPECIES

This section outlines the specific mitigation, monitoring and reporting measures built into the proposed action to minimize or eliminate potential impacts to ESA-listed species of marine mammals, sea turtles, birds, and fishes. Additional mitigation, monitoring, or reporting measures may be added during the Federal ESA Section 7 process or through any issued BOEM leases or other authorizations. Also, during the MMPA authorization process for specific surveys, the NMFS may require additional or different mitigation measures to avoid/minimize impacts on marine mammals. BOEM will require within any G&G activity it authorizes that the operator obtain an MMPA authorization from NMFS prior to conducting any activity that may take marine mammals.

7.1. PROTECTIVE MEASURES FOR LISTED MARINE MAMMALS AND SEA TURTLES

7.1.1. Time-Area Closure for North Atlantic Right Whales

The proposed action includes a time-area closure intended to avoid impacts from vessel strikes or ensonification of the water column on North Atlantic right whales to the maximum extent practicable. It is estimated that this closure would avoid about two-thirds of the incidental takes of North Atlantic right whales by active acoustic sound sources over the period of the Programmatic EIS. Although right whales could occur anywhere within the BA Area, they are most likely to be found in the calving/nursery areas offshore the southeastern U.S. coast during the winter months and near the South Atlantic and Mid-Atlantic coast during their seasonal migrations (Knowlton et al., 2002).

The locations and timing of the closure are shown in **Figure A-23**. The total closure area under the proposed action would be 7,589,594 ac (30,714 km^2) or approximately 4 percent of the BA Area. No airgun surveys would be authorized within the designated right whale critical habitat from November 15 through April 15 nor within the Mid-Atlantic and Southeast U.S. SMAs during the times when vessel speed restrictions are in effect under 50 CFR 224.105. However, surveys proposed in the critical habitat and SMAs with sources other than air guns may be considered on a case-by-case. Any such authorization may include additional mitigation and monitoring requirements to avoid or significantly reduce impacts on right whales. Other supporting surveys (e.g., biological surveys) would not be affected by this restriction.

The Southeast U.S. SMA, with seasonal restrictions in effect from November 15 to April 15, is a continuous area that extends from St. Augustine, Florida, to Brunswick, Georgia, extending 37 km (20 nmi) from shore (**Figure A-5**). The Mid-Atlantic U.S. SMA, with seasonal restrictions from November 1 through April 30, is a combination of both continuous areas and half circles drawn with 37-km (20-nmi) radii around the entrances to certain bays and ports. Within the BA Area, the Mid-Atlantic U.S. SMA includes a continuous zone extending between Wilmington, North Carolina, and Brunswick, Georgia, as well as the entrance to Delaware Bay (Ports of Wilmington [Delaware] and Philadelphia), the entrance to Chesapeake Bay (Ports of Hampton Roads and Baltimore), and the Ports of Morehead City and Beaufort, North Carolina (**Figure A-5**).

Exceptions to the right whale time-area closure could occur if a survey was needed to serve important operational or monitoring requirements for a particular project. For example, monitoring surveys for renewable energy (e.g., scour, cable burial) might need to take place at fixed intervals to capture seasonal changes or safety-related conditions. Another example would be a marine minerals project in which dredging is not seasonally restricted and real-time bathymetry data must be collected to track dredging operations or pre- and post-bathymetric surveys must be collected immediately before or after dredging to establish sand volumes borrowed.

7.1.2. Seismic Airgun Survey Protocol

All authorizations for seismic airgun surveys (those involving airguns as an acoustic source) would include a survey protocol that specifies mitigation measures for protected species, including an exclusion zone, ramp-up requirements, visual monitoring by protected species observers prior to and during seismic airgun surveys, and array shutdown requirements. The protocol specifies the conditions under which airgun arrays can be started and those under which they must be shut down. It also includes the optional use of passive acoustic monitoring (PAM) to help detect vocalizing marine mammals. The protocol requirements apply specifically to airguns, not electromechanical sources such as side-scan sonars, boomer and chirp subbottom profilers, and single beam or multibeam depth sounders that may be operating concurrently during seismic airgun surveys.

A proposed seismic airgun survey protocol is provided as the **Attachment** to this BA. The draft protocol is based on Joint BOEM-BSEE NTL 2012-G02 (*Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program*) (USDOI, BOEM and BSEE, 2012a), with key exceptions as noted in the protocol. This protocol would be required in all water depths for any surveys using air guns.

7.1.2.1. Rationale

The purpose of the operational measures included in the seismic airgun survey protocol is to prevent injury to marine mammals and sea turtles and to avoid Level A harassment of marine mammals to the maximum extent practicable.

For the analysis in the Programmatic EIS, two sizes of airgun arrays were modeled, based on current usage in the Gulf of Mexico, and considered representative for potential Atlantic G&G seismic surveys:

- large airgun array (5,400 in.^{3}). This array was used to represent sound sources for deep penetration seismic surveys, including 2D, 3D, WAZ, and other variations.
- small airgun array (90 in.^{3}). This array was used to represent sound sources for HRG surveys for oil and gas exploration sites.

Detailed acoustic characteristics of airguns are discussed in **Appendix D** of the Draft Programmatic EIS. Broadband source levels are 230.7 decibels (dB) re 1 micropascal (μPa) for the large airgun array and 210.3 dB re 1 μPa for the small array (**Table A-14**). Although airguns have a frequency range from about 10-2,000 Hz, most of the acoustic energy is radiated at frequencies below 200 Hz.

Acoustic pulses from airguns are within the hearing range of all marine mammals in the BA Area. All of the mysticetes occurring in the BA Area are low-frequency cetaceans (7 Hz-22 kHz), and most of the odontocetes are mid-frequency cetaceans (150 Hz-160 kHz), with the exception of the harbor porpoise (a high-frequency cetacean, 200 Hz-180 kHz). Manatees have hearing capabilities that are generally similar to phocid pinnipeds, with functional hearing between about 250 Hz and ~90 kHz. Airgun pulses are also within the hearing range of sea turtles, whose best hearing is mainly below 1,000 Hz (see **Section 3.2.7**).

To reduce the risk of injury and Level A harassment, the seismic airgun survey protocol would establish an exclusion zone based on the predicted range at which animals could be exposed to a received SPL of 180 dB re 1 μPa, which is the current NMFS criterion for Level A harassment of cetaceans (and considered conservative and protective). The radius of the exclusion zone would be calculated on a survey-specific basis, but would not be less than 500 m (1,640 ft). This exclusion zone applies specifically to airguns, not electromechanical sources such as side-scan sonars, boomer and chirp subbottom profilers, and single beam or multibeam depth sounders that may be operating concurrently during seismic airgun surveys. Although there are no NMFS noise exposure criteria for sea turtles, the mitigation measures are expected to similarly reduce the risk of temporary or permanent hearing loss in sea turtles. The operational mitigation measures would reduce the extent of, but not prevent, behavioral responses including Level B harassment of marine mammals. Other measures such as the time-area closure for North Atlantic right whales (**Section 7.1.1**) would help to reduce the risk of those impacts. Key elements of the protocol are discussed below.

7.1.2.2. Ramp-Up

Ramp-up (also known as "soft start") entails the gradual increase in intensity of an airgun array over a period of 20 min or more, until maximum source levels are reached. The intent of ramp-up is to either avoid or reduce the potential for instantaneous hearing damage to an animal (from the sudden initiation of an acoustic source at full power) that might be located in close proximity to an airgun array. Increasing sound levels are designed to warn animals of pending seismic operations, and to allow sufficient time for those animals to leave the immediate area. Under optimal conditions, sensitive individuals are expected to move out of the area, beyond the range where hearing damage might occur.

Ramp-up has become a standard mitigation measure in the U.S. and worldwide. The International Association of Geophysical Contractors (IAGC) recommends ramp-up in its seismic survey guidelines (IAGC, 2011). In the Gulf of Mexico, the BOEM requires ramp-up for operators working in water depths >200 m throughout the Gulf and all OCS waters of the Eastern Gulf of Mexico Planning Area under Joint BOEM-BSEE NTL 2012-G02 (USDOI, BOEM and BSEE, 2012a).

7.1.2.3. Exclusion Zone

The seismic airgun survey protocol includes an exclusion zone to prevent injury to marine mammals and sea turtles and to avoid Level A harassment of marine mammals to the maximum extent practicable.

The radius of the exclusion zone would be based on the predicted range at which animals could be exposed to a received SPL of 180 dB re 1 µPa, which is the current NMFS criterion for Level A harassment of cetaceans. The radius of the exclusion zone would be calculated on a survey-specific basis, but would not be less than 500 m (1,640 ft). This exclusion zone applies specifically to airguns, not electromechanical sources such as side-scan sonars, boomer and chirp subbottom profilers, and single beam or multibeam depth sounders that may be operating concurrently during seismic airgun surveys.

Although the NMFS also uses a criterion of 190 dB re 1 µPa for Level A harassment of pinnipeds, based on the rare occurrence of pinnipeds in the BA Area it is unlikely that a smaller exclusion zone based on the 190-dB criterion would be appropriate for any seismic airgun survey there. There are no noise exposure criteria for sea turtles, but a 180-dB exclusion zone is expected to prevent mortalities, injuries, and auditory impacts on sea turtles to the maximum extent practicable.

Based on calculations in **Appendix D** of the Draft Programmatic EIS and summarized in **Table A-15**, the 180-dB zone for a large airgun array (5,400 $in.^3$) ranges from 799-2,109 m (2,622-6,920 ft), with a mean of 1,086 m (3,563 ft). Marine mammals can be detected at distances of up to several kilometers, depending on sea state and the animal's size and behavior. Sea turtles are not likely to be detected beyond 500 m (1,640 ft).

For oil and gas HRG surveys using a small airgun array (90 $in.^3$), the 180-dB zone ranges from 76-186 m (249-610 ft), with a mean of 128 m (420 ft) (**Table A-15**). A 500-m (1,640-ft) radius exclusion zone can be effectively monitored and would encompass the zone where Level A harassment could occur.

7.1.2.4. Visual Monitoring by Protected Species Observers

The seismic airgun survey protocol includes visual monitoring of the exclusion zone by trained protected species observers. At least two protected species observers will be required on watch aboard seismic vessels at all times during daylight hours (dawn to dusk – i.e., from about 30 min before sunrise to 30 min after sunset) when seismic operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit. Ongoing activities may continue but may not be initiated under such conditions (i.e., without appropriate pre-activity monitoring). Operators may engage trained third party observers, utilize crew members after training as observers, or use a combination of both third party and crew observers.

The main tasks of protected species observers are to monitor the exclusion zone for protected species and to observe and document their presence and behavior. Observers search the area around the vessel using high-powered, pedestal-mounted, "Big Eye" binoculars, hand-held binoculars, and the unaided eye. For larger monitoring programs with a specified visual observation platform, two observers survey for protected species generally using the high-powered binoculars, while a third observer searches with the unaided eye and occasionally hand-held binoculars, and serves as data recorder. If the vessel is utilizing a PAM system, a fourth observer will be assigned to monitor that station and communicate with the third observer on the visual observing platform. Data are recorded on paper sheets and/or a laptop computer that has direct input from the vessel's GPS navigation system. Observers rotate among the duty stations at regular intervals, and alternate work and rest periods based upon a pre-determined schedule. In the event a marine mammal is sighted or otherwise detected within the impact zone, seismic operations are suspended until the animal leaves the area (see **Attachment**).

Visual shipboard monitoring is affected by limitations on sightability of individuals due to poor visibility (fog, elevated Beaufort sea state, nighttime operations), species detectability (cryptic species), and/or observer fatigue. Routine activities of marine mammals (e.g., diving duration patterns, pod size, overt behaviors) show considerable variability between species, thereby affecting whether or not animals are sighted (i.e., availability bias). During nighttime operations or during periods of reduced visibility, several options are available to allow for continual monitoring of the impact zone (e.g., shipboard lighting of waters around the vessel, use of enhanced vision equipment, night-vision equipment, and acoustic monitoring [both active and passive]). However, the efficiency of visual monitoring during nighttime hours, using shipboard lighting or enhanced vision equipment, is limited when compared with visual monitoring during daylight hours.

7.1.2.5. Shutdown Requirements

The seismic airgun survey protocol will require shutdown of the airgun array any time a listed marine mammal or sea turtle is observed within the exclusion zone, whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone. In the event of a shutdown, seismic operations and ramp-up of airguns would resume only when the sighted animal has cleared the exclusion zone and no other marine mammals or sea turtles have been sighted within the exclusion zone for at least 30 min.

7.1.2.6. Effectiveness of Seismic Airgun Survey Protocol

The seismic airgun survey protocol is adapted from current requirements used for seismic surveys in the Gulf of Mexico. Similar protocols are used internationally (Joint Nature Conservation Committee [JNCC] 2010; Blue Planet Marine, 2010; NSF and USDOI, USGS, 2011), and it is expected that they would help to prevent mortalities or injuries of marine mammals and sea turtles. However, most mitigation measures are based on a "common sense" approach and their effectiveness is not well documented (Pierson et al., 1998; Stone, 2003; Weir et al., 2006; Weir and Dolman, 2007; Compton et al., 2007; Parsons et al., 2009).

The effectiveness of a mitigation protocol for seismic airgun surveys is inherently difficult to evaluate. First, the effect that it is intended to prevent (Level A harassment, or more specifically, the onset of auditory injury such as PTS) cannot be measured in the field. Second, there is no perfect monitoring system that could be used to evaluate whether all marine mammals within a certain radius (exclusion zone) have been detected. Aspects of the seismic airgun survey protocol that are relevant to mitigation effectiveness are discussed briefly below.

Ramp-up. Ramp-up or "soft start" procedures are intended to give adequate time for protected species to leave the vicinity before an airgun array reaches full power. Although ramp-up is widely used, there is little information on its effectiveness (Weir and Dolman, 2007; Parsons et al., 2009). Observations of cetaceans during ramp-up are mixed, and the interpretation of marine mammal responses to the airgun source is problematic (Parsons et al., 2009). Stone and Tasker (2006) found no difference in the distance of cetaceans from airgun arrays during ramp-up as compared to periods when airguns were off or in full operation. Weir (2008a) noted that one group of pilot whales animals altered their behavior and direction, moving away from the seismic source, and Weir (2008b) observed that Atlantic spotted dolphins moved away from a seismic vessel during a ramp-up. Jochens et al. (2008) reported no lateral avoidance of airgun sources by sperm whales exposed to maximum received sound levels between 111 to 147 dB re 1 μPa at ranges of approximately 1.4-12.6 km from the sound source. Compton et al. (2007) hypothesized that ramp-up could result in attraction of animals by initially weak sounds. Parsons et al. (2009) noted that some animals may respond by moving vertically rather than laterally away from the source, which could place them at greater risk.

The existing data do not consistently support or refute the idea that ramp-up would cause marine mammals to avoid approaching an airgun array operating at full power. However, without ramp-up, there is the possibility that an animal's first exposure to a source would be at a level sufficient to cause TTS or PTS, whereas ramp-up would prevent that from occurring (Hannay et al., 2011).

Size of the Exclusion Zone. The seismic airgun survey protocol includes an exclusion zone based on the predicted range at which animals could be exposed to a received sound pressure level of 180 dB re 1 μPa, the current NMFS criterion for Level A harassment of cetaceans. The radius of the exclusion zone would be calculated on a survey-specific basis, but would not be less than 500 m (1,640 ft). A 500-m (1,640-ft) zone is common internationally and is current practice in the Gulf of Mexico under Joint BOEM-BSEE NTL 2012-G02 (USDOI, BOEM and BSEE, 2012a).

Critiques of seismic survey mitigation have questioned whether the 500-m (1,640-ft) zone is "an arbitrary figure, given that it is a relatively round number" (Parsons et al., 2009) and stated that "there is clearly a need to incorporate the effect of varying airgun volume on [exclusion zone] calculations" (Weir and Dolman, 2007). The seismic airgun survey protocol for the proposed action addresses this issue by calculating the exclusion zone radius on a survey-specific basis. This is similar to the approach used by NSF and USDOI, USGS (2011) for seismic surveys worldwide and is typically used by NMFS in its Incidental Harassment Authorizations for seismic surveys (e.g., USDOC, NMFS, 2012d,e).

Another effectiveness issue that has been raised with respect to the exclusion zone is that a 500-m (1,640-ft) radius is less than the distance at which behavioral responses to airguns have been detected in various studies (Parsons et al., 2009). However, the purpose of the exclusion zone is to prevent injury, not behavioral responses. The BOEM believes that it would not be feasible to establish an exclusion zone that would prevent behavioral responses (Level B harassment). Based on calculations as summarized in **Table A-14**, a Level B harassment zone based on the 160-dB range could extend up to 15 km (9.3 mi) from a large airgun array (5,400 $in.^3$) and up to 3 km (1.9 mi) from a small airgun array (90 $in.^3$) depending on the geographic location and season modeled. The area that would have to be monitored would be much larger; the area within a 15-km radius (the maximum extent of the 160 dB contour) is 51 times the area within a 2.1-km radius (the maximum extent of the 180 dB contour). Therefore, it is not feasible to routinely require monitoring of a 160-dB exclusion zone for seismic surveys using shipboard protected species observers. In addition, although 160 dB is the current Level B criterion for impulse sources, there is much variability and ongoing research about the levels of received sound that can cause behavioral responses in marine mammals, as well as the biological significance of those responses (NRC, 2005; Southall et al., 2007; Ellison et al., 2011). An exclusion zone based on a 160-dB radius may not prevent all behavioral responses and could trigger array shutdowns even when no response is observable within that radius. Further, BOEM will require in any G&G authorization it issues that operators obtain an MMPA authorization from NMFS prior to conducting activities under BOEM purview that may take marine mammals. Although this MMPA authorization does not prevent Level B Harassment, it will ensure that NMFS can make a determination on whether any potential taking would meet the requirements of the MMPA (i.e., be no more than negligible).

Visual Monitoring. The seismic airgun survey protocol includes visual monitoring of the 180-dB exclusion zone by protected species observers. Shipboard detection of marine mammals has been studied extensively, but mainly in the context of research surveys (e.g., Barlow et al., 2011). The results are difficult to extrapolate to mitigation surveys because of differences in equipment, observer experience, and sea state conditions. In particular, most research surveys are conducted by highly experienced observers and use data acquired under excellent or good sea state conditions, whereas seismic surveys can be conducted under much worse conditions including nighttime (Barlow and Gisiner, 2006).

The blue whale, fin whale, humpback whale, North Atlantic right whale, sei whale, and sperm whale are all large whales that, when present on the surface, are likely to be detected by experienced observers under good or excellent sea state conditions. However, they would not be visually detectable at night, and the probability of detection during the daytime could be reduced under conditions of poor visibility and/or sea state. In addition, even during daylight hours a certain proportion of the population is submerged and therefore unavailable for visual detection. This is referred to as "availability bias" (Marsh and Sinclair, 1989). Based on dive characteristics as summarized in **Appendix E** of the Programmatic EIS, dive times for all of these species except the sperm whale are typically in the range of 5-20 min with surface times ranging from less than a minute to a few minutes. Although there is a good chance that these whales would be on the surface (available for detection) at some time during the passage of a seismic survey vessel through an area, there is also a possibility that an animal could emerge within the exclusion zone (e.g., a seismic survey vessel traveling at 5 kn [2.6 m/s] would travel 2.3 km [1.4 mi] during a 15 min dive).

The sperm whale is a deep-diving species that may remain submerged for much longer periods; dive times in the Atlantic have been reported to average 40-45 min (Palka and Johnson, 2007). In the Gulf of Mexico, a typical deep dive of a tagged sperm whale lasts 45 min followed by a surface interval of 9 min (Jochens et al., 2008). Palka and Johnson (2007) estimated that if tagged animals are representative of the dive patterns of the Atlantic sperm whale population, then there is a 27 percent chance that a single sperm whale would at the surface, available to be detected by a visual sighting team. Because of their deep and prolonged dives, sperm whales are more likely than the other listed whales to avoid visual detection.

Sea turtles are difficult to detect on the sea surface except under excellent sea states, and they spend most of their time submerged (Eckert et al., 1986, 1989; Keinath and Musick, 1993). Therefore, the probability of shipboard observers detecting sea turtles within the exclusion zone would be low.

The experience and qualifications of protected species observers are an important factor in mitigation effectiveness (Weir and Dolman, 2007; Parsons et al., 2009). The seismic airgun survey protocol specifies that all visual observers must have completed a protected species observer training course. The BOEM will not sanction particular trainers or training programs, but has specified the observer qualifications and elements that the training program must include (see **Attachment** to this BA).

Shutdown Requirements. The protocol requirements include the shutdown of all airguns at any time a listed marine mammal or sea turtle is detected entering or within the exclusion zone. Shutdown is considered to be a very effective mitigation measure because it would remove the sound source that is causing an impact. However, its effectiveness is limited by the ability of the operator to detect marine mammals by visual observations (and PAM if used). Shutdowns based on visual observations would be limited to daylight hours. Shutdowns could occur at night if vocalizing marine mammals were detected using PAM, but it is expected that PAM may only detect a fraction of the population (Robinson et al., 2008).

The shutdown requirements for the proposed action differ from those currently used in the Gulf of Mexico under Joint NTL 2012-G02. Shutdown of the airgun array would be required any time a listed marine mammal or sea turtle is observed within the exclusion zone, whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone. In contrast, in the Gulf of Mexico, Joint NTL 2012-G02 requires the exclusion zone to be clear of all marine mammals and sea turtles for startup, but shutdown is required only for *whales* entering the exclusion zone (USDOI, BOEM and BSEE, 2012a).

Passive Acoustic Monitoring. The seismic airgun survey protocol also includes the optional use of PAM to help detect vocalizing marine mammals. Towed PAM systems have been used with some success to supplement visual monitoring of exclusion zones in the Gulf of Mexico, the North Sea, and elsewhere (Bingham, 2011). Despite these successes, a number of limitations and challenges exist including the following (Bingham, 2011):

- Animals can only be detected if they are vocalizing, which is not always the case;
- The range to which an animal can be detected varies with the characteristics of its sounds (e.g., frequency, bandwidth, source level, directionality), oceanographic and bathymetric conditions, design features of the towed array (e.g., number, spacing and depth of the individual sensor elements), design features of the PAM software, the speed at which the vessel is traveling, and the characteristics of the noise generated by the vessel;
- Currently available towed PAM systems do not have a proven ability to detect marine mammals that call in frequencies overlapping those of vessel noise;
- Accurate range estimation can be difficult. With most currently available towed PAM systems deployed from seismic survey vessels, estimating the location of a calling animal requires multiple detections of the same animal in order to compute multiple bearings to that animal as the vessel steams forward. Estimating the location

of a calling marine mammal becomes problematic when it is in line with (forward and aft of) the axis of the towed PAM hydrophone streamer.
- In general, the effective application of a towed PAM system requires well-trained, experienced PAM technicians operating the equipment;

To the extent that operators use PAM to complement visual monitoring during surveys conducted under the proposed action, the BOEM expects that it will improve detection of marine mammals. However, the effectiveness cannot be estimated.

Time-Area Closure. In addition to the seismic airgun survey protocol, the proposed action includes a time-area closure intended to avoid most impacts from vessel strikes or ensonification of the water column on North Atlantic right whales (see **Section 7.1.1**). It is estimated that this closure would avoid about 67 percent of the incidental takes of North Atlantic right whales by active acoustic sound sources over the period of the Programmatic EIS. As noted by Parsons et al. (2009) and Barlow and Gisiner (2006), scheduling surveys to avoid certain areas and/or time periods can be a highly effective method of mitigating impacts.

Conclusions. The seismic airgun survey protocol is generally consistent with current practice in the U.S. and internationally. It differs from the Gulf of Mexico protocol in several key respects – it would be applied throughout the BA Area (no water depth limits) and it would require survey-specific calculation of the exclusion zone radius (rather than using 500 m [1,640 ft] for all surveys). Although the effectiveness cannot be quantified, the BOEM expects that the protocol would prevent mortality and injury of listed marine mammals and sea turtles to the maximum extent practicable. The NSF and USDOI, USGS (2011), in an EIS for worldwide seismic surveys, concluded that a "visual monitoring program, which is consistent with current practices, will be sufficient to visually detect, with reasonable certainty, most marine mammals within or entering [mitigation zones]."

7.1.3. HRG Survey Protocol (Renewable Energy and Marine Minerals Sites)

The HRG surveys of renewable energy and marine minerals sites would use only electromechanical sources such as side-scan sonar, boomer and chirp subbottom profilers, and single beam and multibeam depth sounders. The BOEM does not expect that airguns would be used for these surveys. All authorizations for non-airgun HRG surveys would include requirements for visual monitoring of an exclusion zone by protected species observers and startup and shutdown requirements.

The HRG surveys for oil and gas exploration and development sites typically use the electromechanical acoustic sources operating concurrently with airgun arrays. These surveys would be subject to the seismic airgun survey protocol described in **Section 7.1.2** and detailed in the **Attachment**.

7.1.3.1. Rationale

Important considerations in defining an exclusion zone (or "safe" range) include the source level, operating frequencies, pulse duration, and directivity of the source as well as the hearing capabilities of the receiving animals. Acoustic characteristics of electromechanical sources are discussed in detail in **Appendix D** of the Draft Programmatic EIS and summarized in **Table A-14**.

Based on a review of marine mammal hearing, Southall et al. (2007) recognized three cetacean groups: low-frequency cetaceans (7 Hz to 22 kHz), mid-frequency cetaceans (150 Hz to 160 kHz) and high-frequency cetaceans (200 Hz to 180 kHz). Boomer pulses are within the hearing range of all three cetacean groups. However, the operating frequency of the representative multibeam system (240 kHz) is above the hearing range of all three groups. For side-scan sonar, the 100-kHz operating frequency is within the hearing range of mid- and high-frequency cetaceans, but the 400-kHz frequency is above the range of all groups. For the chirp subbottom profiler, the 3.5 kHz and 12 kHz frequencies are within the hearing range of all three cetacean groups, but the 200 kHz is above the range of all groups. Frequencies emitted by individual equipment may differ from these representative systems selected for programmatic analysis.

Sea turtles are low-frequency specialists whose best hearing is mainly below 1,000 Hz (see **Section 3.2.7**). Acoustic signals from electromechanical sources other than the boomer are not likely to be detectable by sea turtles. Because of the relatively low source level of the boomer (as discussed below), sea turtles are unlikely to hear boomer pulses unless they are very near the source.

7.1.3.1.1. Injury Ranges Calculated Using the 180-dB NMFS Criterion

To reduce the risk of injury and Level A harassment of marine mammals, the HRG survey protocol would establish an exclusion zone based on the predicted range at which animals could be exposed to a received SPL of 180 dB re 1 µPa, which is the current NMFS criterion for Level A harassment of cetaceans. The operational mitigation measures would not prevent all Level A harassment and would reduce the extent of, but not prevent, behavioral responses including Level B harassment.

Table A-15 lists the maximum 180-dB range calculated for electromechanical sources, based on acoustic modeling in **Appendix D** of the Draft Programmatic EIS. The range of values reflects the various geographic and seasonal scenarios modeled. The 180-dB radius ranged from 38-45 m (125-148 ft) for the boomer and from 32-42 m (105-138 ft) for the chirp subbottom profiler. The 180-dB radius was 27 m (89 ft) for the multibeam depth sounder under all scenarios. The side-scan sonar had the largest 180-dB radius, ranging from 128-192 m (420-630 ft).

The initial 180-dB calculations in **Table A-15** are based on nominal source levels and do not take into account the pulse duration. As indicated in the table, the pulses produced by all of the electromechanical sources are much shorter than 1 s. As summarized by Au and Hastings (2008), when receiving tone pulses, the mammalian ear behaves like an integrator with an "integration time constant." Energy is summed over the duration of a pulse until the pulse is longer than the integration time constant. Studies of bottlenose dolphins by Johnson (1968) indicate an integration time constant of approximately 100 ms. A 10-ms pulse with a received SPL of 180 dB would be integrated over a 100-ms period, resulting in a 10-fold (10 dB) reduction. Using the assumption of a 100-ms integration time, the 180-dB radii for side-scan sonar and multibeam depth sounder were recalculated to account for short pulse duration as shown in **Table A-15**. For the boomer and multibeam depth sounder, the recalculated 180-dB radius was <5 m under all scenarios. The recalculated 180-dB radius ranged from 65-96 m (213-315 ft) for the side-scan sonar and from 26-35 m (85-115 ft) for chirp subbottom profiler. Specific considerations for each source are discussed below.

Boomer

The frequency range of the representative boomer (200 Hz to 16 kHz) is entirely within the hearing range of all cetacean groups and is also within the expected hearing range of sea turtles. Based on a source level of 212 dB re 1 µPa, the 180-dB radius is estimated to range from 38-45 m (125-148 ft) for the various geographic and seasonal scenarios modeled. However, taking into account the short pulse duration (180 microseconds [µs]), the recalculated 180-dB radius is <5 m (16 ft) in all modeled scenarios (**Table A-15**).

Side-Scan Sonar

For the representative side-scan sonar, the 100-kHz operating frequency is within the hearing range of mid- and high-frequency cetaceans, but the 400-kHz frequency is above the range of all groups. Sea turtles are not expected to hear this source. Based on a source level of 226 dB re 1 µPa, the 180-dB radius is estimated to range from 128-192 m (420-630 ft) for the various geographic and seasonal scenarios modeled. Taking into account the short pulse length of 20 ms, the recalculated 180-dB radius ranges from 65-96 m (213-315 ft) (**Table A-15**).

Chirp Subbottom Profiler

The representative chirp subbottom profiler operates at three frequencies: 3.5 kHz, 12 kHz, and 200 kHz. The highest frequency (200 kHz) is above the hearing range for all cetaceans. Sea turtles are not expected to hear this source. Based on a source level of 222 dB re 1 µPa, the 180-dB radius ranges from 32-42 m (105-138 ft) for the various geographic and seasonal scenarios modeled. Because the pulse length of 64 ms is relatively close to the 100 ms integration time assumed for the cetacean ear, the correction for pulse length reduces the ranges only slightly to 26-35 m (85-115 ft) (**Table A-15**).

Multibeam Depth Sounder

Based on a source level of 213 dB re 1 µPa, the 180-dB radius calculated for the multibeam depth sounder is 27 m (89 ft) for all of the geographic and seasonal scenarios modeled (**Table A-15**). Taking into account the short pulse duration (225 µs), the radius is further reduced to <5 m (16 ft) for all modeled scenarios. More importantly, because the operating frequency of the representative multibeam system (240 kHz) is above the hearing range of all three cetacean groups, no auditory impacts are expected. Similarly, sea turtles are not expected to hear this source.

The relatively low risk of auditory impacts on marine mammals from multibeam depth sounders is consistent with a recent analysis by Lurton and DeRuiter (2011) taking into account both the short pulse duration and high directivity of these sources.

7.1.3.1.2. Injury Ranges Calculated Using the Southall Criteria

Based on data for onset of TTS, Southall et al. (2007) proposed dual injury criteria for cetaceans exposed to non-pulse sources. In the Southall et al. (2007) terminology, all of the electromechanical sources evaluated here would be considered non-pulse sources. The first injury criterion is a SEL of 215 dB re 1 μPa^2 s, and the second is a flat-weighted peak pressure exceeding 230 dB re 1 µPa. Injury is assumed to occur if either criterion is exceeded (or both).

For all of the representative electromechanical sources in this Programmatic EIS, the source level is less than 230 dB re 1 µPa and therefore the pressure criterion would not be exceeded and the injury radius is zero. Calculation of the injury radius using the SEL criterion is complicated because exposure depends on the ping rate and the number of pulses an animal receives; however, in general, predicted injury radii are expected to be less than 10 m (33 ft) for all of the sources.

7.1.3.1.3. Level B Harassment Ranges Calculated Using the 160-dB NMFS Criterion

Table A-15 also lists the maximum 160-dB range calculated for electromechanical sources, based on acoustic modeling in **Appendix D** of the Draft Programmatic EIS. The range of values reflects the various geographic and seasonal scenarios modeled. The boomer had the largest 160-dB radius, ranging from 1,054-2,138 m (3,458-7,015 ft), followed by the chirp subbottom profiler (359-971 m or 1,178-3,186 ft), the side-scan sonar (500-655 m or 1,640-2,149 ft), and the multibeam depth sounder (147-156 m or 482-512 ft).

Values taking into account pulse duration are shown in the last column of **Table A-15**. Due to the very short pulse duration, the boomer and multibeam depth sounder have radii of 16 m (52 ft) and 12 m (39 ft), respectively. The recalculated 160-dB radius ranged from 240-689 m (787-2,261 ft) for the chirp subbottom profiler and from 337-450 m (1,106-1,476 ft) for side-scan sonar.

7.1.3.1.4. Discussion and Conclusions

Among the representative electromechanical sources, boomers and multibeam depth sounders pose the smallest risk of auditory impacts to marine mammals. Under all scenarios modeled, the 180-dB radius for both sources is estimated to be <50 m (160 ft) for the nominal source level and <5 m (16 ft) when pulse duration is taken into account. Based on the Southall criteria, the predicted injury radius would be zero for both sources. In addition, the operating frequency of the representative multibeam depth sounder is beyond the range of all three cetacean groups. (Some multibeam depth sounders use different frequencies that are within the cetacean hearing range, but the system modeled here is considered representative of the equipment likely to be used during HRG surveys for renewable energy and marine minerals sites.)

Both the representative side-scan sonar and chirp subbottom profiler could be detectable by cetaceans, depending on the operating frequencies selected. The side-scan sonar operating at 100 kHz would be detectable, and the 180-dB radius is estimated to be 128-192 m (420-630 ft) based on the nominal source level and 65-96 m (213-315 ft) when the short pulse length is taken into account. The chirp subbottom profiler operating at either 3.5 kHz or 12 kHz would be detectable, and the 180-dB radius is estimated to be 32-42 m (105-138 ft) based on the nominal source level and 26-35 m (85-115 ft) when the short pulse length is taken into account. Based on the Southall criteria, predicted injury ranges are less than 10 m (33 ft) for both sources.

Depending on the suite of equipment selected and the operating frequencies selected, there may be no Level A or B harassment of marine mammals. For example, if a survey uses side-scan sonar at 400 kHz, chirp subbottom at 200 kHz, multibeam depth sounder at 240 kHz, and no boomer, then no acoustic harassment of marine mammals would be expected.

For surveys with one or more sources operating at frequencies within the cetacean hearing range, if source levels are low enough, it may be feasible to monitor the entire 160-dB radius. In that case, both Level A and B harassment would be prevented and it would be reasonable to assume that no Incidental Take Authorization (ITA) may be needed. For example, a source level of 206 dB re 1 µPa would have a 160-dB radius of 200 m (656 ft) (based on the simplistic assumption of spherical spreading).

Sea turtles are unlikely to hear the electromechanical sources, except perhaps the boomer, at very close range (e.g., the 180-dB radius is 38-45 m). Vessel strike avoidance measures already included in the Programmatic EIS include a recommended separation distance of 45 m (150 ft) for sea turtles. Therefore, the protocol does not include an exclusion zone or shutdown requirements for sea turtles. However, the exclusion zone would be initially clear of sea turtles prior to startup.

7.1.3.1.5. Practical Considerations

The BOEM expects that a 200-m (656-ft) radius exclusion zone can be effectively monitored from the types of coastal survey vessels expected to be used for HRG surveys of renewable energy and marine minerals sites. The operational ranges for these HRG surveys would be approximately <25 mi from shore and in water <30 m (98 ft) deep. Unlike the large, dedicated vessels used for oil and gas seismic surveys, coastal survey vessels may not have a bridge or elevated viewing platform, and their capability for effectively monitoring a radius larger than a few hundred meters would depend on vessel size and configuration. An exclusion zone radius of 200 m (656 ft) would encompass the 180-dB Level A harassment radius calculated for all of the representative electromechanical sources included in this Programmatic EIS as summarized above. Depending on the source levels of the equipment used on particular surveys, this radius may also encompass the 160-dB Level B harassment zone. The BOEM anticipates that if an operator can effectively monitor the 160-dB zone to prevent both Level A and B harassment of marine mammals, it would be reasonable to assume that an ITA under the MMPA may not be necessary for that particular survey. Therefore, the protocol would allow an operator to monitor a radius larger than 200 m (656 ft) if the operator demonstrates that it can be effectively monitored.

Ramp-up is not expected to be an effective mitigation measure for HRG surveys because electromechanical sources typically are either on or off and are not powered up gradually.

The protocol requires that the exclusion zone be initially clear of all marine mammals and specifies shutdown for any listed marine mammal or sea turtle entering the exclusion zone.

7.1.3.2. Protocol Requirements

1. All HRG surveys must comply with requirements for vessel strike avoidance as detailed in separate guidance in **Section 7.1.4**. The recommended separation distance for North Atlantic right whales of 457 m (1,500 ft) would remain in effect during HRG surveys since it exceeds the exclusion zone radius specified below. Recommended separation distances for other whales and small cetaceans are less than, and would be superseded by, the exclusion zone radius. The exclusion zone must be initially clear of sea turtles as indicated below, but thereafter the vessel strike separation distance of 45 m (150 ft) for sea turtles would be maintained.
2. One protected species observer would be required on watch aboard HRG survey vessels at all times during daylight hours (dawn to dusk – i.e., from about 30 min before sunrise to 30 min after sunset) when survey operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit. Ongoing activities may continue but may not be initiated under such conditions (i.e., without appropriate pre-activity monitoring). Operators may engage trained third party observers, utilize crew members after training as observers, or use a combination of both third party and crew observers.

3. The following additional requirements apply only to HRG surveys in which one or more active acoustic sound sources will be operating at frequencies less than 200 kHz.
   a. A 200-m (656-ft) radius exclusion zone will be monitored around the survey vessel. If the exclusion zone does not encompass the 160-dB Level B harassment radius calculated for the acoustic source having the highest source level, BOEM will consult with NMFS about additional requirements. On a case-by-case basis, BOEM may authorize surveys having an exclusion zone larger than 200 m (656 ft) to encompass the 160-dB radius if the applicant demonstrates that it can be effectively monitored.
   b. Active acoustic sound sources must not be activated until the protected species observer has reported the exclusion zone clear of all marine mammals and sea turtles for 30 min.
   c. Except as noted in (d) below, if any listed marine mammal or sea turtle is sighted within or transiting towards the exclusion zone, an immediate shutdown of the equipment will be required. Subsequent restart of the equipment may only occur following clearance of the exclusion zone for 30 min.

The HRG surveys of renewable energy and marine minerals sites in the SMAs for the North Atlantic right whale would be reviewed on a case-by-case basis, and authorizations may include additional mitigation and monitoring requirements to avoid or reduce impacts on right whales.

7.1.4. Guidance for Vessel Strike Avoidance

All authorizations for shipboard surveys would include guidance for vessel strike avoidance. The guidance would be similar to Joint BOEM-BSEE NTL 2012-G01 (*Vessel Strike Avoidance and Injured/Dead Protected Species Reporting*) (USDOI, BOEM and BSEE, 2012b), which incorporates the NMFS "Vessel Strike Avoidance Measures and Reporting for Mariners" addressing protected species identification, vessel strike avoidance, and injured/dead protected species reporting. Key elements of the guidance are as follows:

1. Vessel operators and crews must maintain a vigilant watch for marine mammals and sea turtles and slow down or stop their vessel to avoid striking protected species.
2. When whales are sighted, maintain a distance of 91 m (300 ft) or greater from the whale. If the whale is believed to be a North Atlantic right whale, the vessel must maintain a minimum distance of 457 m (1,500 ft) from the animal (50 CFR 224.103).
3. When sea turtles or small cetaceans are sighted, the vessel must maintain a distance of 45 m (150 ft) or greater whenever possible.
4. When cetaceans are sighted while a vessel is underway, the vessel must remain parallel to the animal's course whenever possible. The vessel must avoid excessive speed or abrupt changes in direction until the cetacean has left the area.
5. Reduce vessel speed to 10 kn (18.5 km/h) or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near an underway vessel when safety permits. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised.
6. Whales may surface in unpredictable locations or approach slowly moving vessels. When animals are sighted in the vessel's path or in close proximity to a moving vessel, the vessel must reduce speed and shift the engine to neutral. The engines must not be engaged until the animals are clear of the area.
7. Vessel crews would be required to report sightings of any injured or dead marine mammals or sea turtles to BOEM and NMFS within 24 hr, regardless of whether the injury or death was caused by their vessel.

In addition, vessel operators would be to required to comply with the NMFS marine mammal and sea turtle viewing guidelines for the Northeast Region (USDOC, NMFS [2012b] for surveys offshore Delaware, Maryland, or Virginia) or the Southeast Region (USDOC, NMFS [2012c] for surveys offshore

North Carolina, South Carolina, Georgia, or Florida) or combined guidance if recommended by NMFS. These measures are meant to reduce the potential for vessel harassment or collision with marine mammals or sea turtles regardless of what activity a vessel is engaged in.

The guidance will also incorporate the NMFS Compliance Guide for the Right Whale Ship Strike Reduction Rule (50 CFR 224.105), which limits vessel speed to 18.5 km/h (10 kn) in the Mid-Atlantic and Southeast U.S. SMAs for North Atlantic right whales during migration (**Figure A-21**). Vessel speed restrictions in these areas are in effect between November 1 and April 30 in the Mid-Atlantic and between November 15 and April 15 in the southeast U.S.

7.1.5. Guidance for Marine Debris Awareness

All authorizations for shipboard surveys would include guidance for marine debris awareness. The guidance would be similar to BSEE NTL No. 2012-G01 (*Marine Trash and Debris Awareness and Elimination*) (USDOI, BSEE, 2012). All vessel operators, employees, and contractors actively engaged in G&G surveys must be briefed on marine trash and debris awareness elimination as described in this NTL except that BOEM will not require applicants to undergo formal training or post placards. The applicant will be required to ensure that its employees and contractors are made aware of the environmental and socioeconomic impacts associated with marine trash and debris and their responsibilities for ensuring that trash and debris are not intentionally or accidentally discharged into the marine environment where it could affect protected species. The above referenced NTL provides information that applicants may use for this awareness training.

7.2. Protective Measures for Listed Birds

No mitigation measures have been identified specifically for listed bird species. The piping plover and red knot are shorebirds that are unlikely to come into contact with G&G surveys. The roseate tern and Bermuda petrel may come into contact with G&G activities, but no adverse impacts are expected, as discussed in **Section 6.3**. Given the typical low density of seabirds offshore, it is likely that few if any of these birds would be exposed to G&G survey activities other than on an occasional basis. The marine debris awareness guidance (**Section 7.1.5**) will help to minimize the risk of trash and debris being released into the marine environment where it could affect listed birds.

7.3. Protective Measures for Listed Fishes

No mitigation measures have been identified specifically for listed fish species. During seismic airgun surveys, ramp-up procedures for marine mammals and sea turtles may provide an opportunity for fishes such as alewife and blueback herring near airgun arrays to avoid exposure to high SPLs. However, ramp-up is not likely to be helpful to demersal fishes such as the smalltooth sawfish, shortnose sturgeon, or Atlantic sturgeon because they are beneath the airgun array and would not gain much benefit from moving laterally along the seafloor.

The BOEM will require site-specific information regarding potentially sensitive benthic communities prior to approving any G&G activities involving seafloor-disturbing activities or placement of bottom-founded equipment or structures in the BA Area. The main purpose of the review is to avoid coral, hard/live bottom, and chemosynthetic communities. However, if the review identified habitats that serve as important feeding or aggregation areas for any of the listed fish species, the BOEM would include this information in its evaluation to ensure that impacts on listed species are avoided to the extent practicable.

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ATTACHMENT: DRAFT SEISMIC AIRGUN SURVEY PROTOCOL

Note: The following draft protocol is based on Joint BOEM-BSEE NTL 2012-G02 (*Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program*) (USDOI, BOEM and BSEE, 2012a) with the following key exceptions:

- The protocol would apply to all seismic surveys in the BA Area regardless of water depth. Joint NTL 2012-G02 does not apply to water depths less than 200 m (656 ft) in the Gulf of Mexico west of 88º W.
- The radius of the exclusion zone would be based on the predicted range at which animals could be exposed to a received SPL of 180 dB re 1 µPa, which is the current NMFS criterion for Level A harassment of cetaceans. The radius would be calculated for each survey but would not be less than 500 m (1,640 ft). In contrast, Joint NTL 2012-G02 specifies a single, fixed radius of 500 m (1,640 ft).
- Shutdown of the airgun array would be required any time a marine mammal or sea turtle is observed within the exclusion zone, whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone. There would be an exception for dolphins approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. In contrast, Joint NTL 2012-G02 requires the exclusion zone to be clear of all marine mammals and sea turtles for startup, but shutdown is required only for whales entering the exclusion zone.

BACKGROUND

The use of an airgun or airgun arrays while conducting seismic operations may have an impact on marine wildlife, including marine mammals and sea turtles. Some marine mammals, such as the North Atlantic right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), and Florida manatee (*Trichechus manatus latirostris*), that inhabit the BA Area are protected under the ESA, and all marine mammals are protected under the MMPA. All five sea turtle species inhabiting the BA Area are protected under the ESA. They are the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), Kemp's ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*).

In order to protect marine mammals and sea turtles during seismic operations, the NMFS requires seismic operators to use ramp-up and visual observation procedures when conducting seismic surveys. Procedures for ramp-up, protected species observer training, visual monitoring, and reporting are described in detail in this protocol. These mitigation measures apply to all seismic survey operations conducted regardless of water depth. Performance of these mitigation measures is also a condition of the approval of applications for geophysical permits. Permittees must demonstrate compliance with these mitigation measures by submitting to BOEM certain reports detailed in this protocol. The measures contained herein would apply to all on-lease surveys conducted under 30 CFR 550 and all off-lease surveys conducted under 30 CFR 551 in the BA Area. In addition, the measures would apply to any deep penetration seismic surveys conducted to evaluate formation suitability for carbon sequestration in the renewable energy program.

DEFINITIONS

Terms used in this protocol have the following meanings:

1. Airgun means a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.
2. Ramp-up means the gradual increase in emitted sound levels from an airgun array by systematically turning on the full complement of an array's airguns over a period of time.

3. Visual monitoring means the use of trained protected species observers to scan the ocean surface visually for the presence of marine mammals and sea turtles. These observers must have successfully completed a visual observer training program as described below. The area to be scanned visually includes, but is not limited to, the exclusion zone. Visual monitoring of an exclusion zone and adjacent waters is intended to establish and, when visual conditions allow, maintain a zone around the sound source and seismic vessel that is clear of marine mammals and sea turtles, thereby reducing or eliminating the potential for injury.
4. Exclusion zone means the area at and below the sea surface within a radius to be determined by calculating the maximum range at which animals could be exposed to a received SPL of 180 dB re 1 µPa, which is the current NMFS criterion for Level A harassment of cetaceans. The distance is calculated from the center of an airgun array. Each survey vessel must maintain its own unique exclusion zone. The radius of the exclusion zone must be calculated independently for each survey based on the configuration of the airgun array and the ambient acoustic environment, but must not be less than 500 m (1,640 ft).
5. Dolphins mean all marine mammal species in the family Delphinidae. This includes, among others, killer whales, pilot whales, and all of the "dolphin" species.

Ramp-Up Procedures

The intent of ramp-up is to warn marine mammals and sea turtles of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. Under normal conditions, animals sensitive to these activities are expected to move out of the area. For all seismic surveys, including airgun testing, use the ramp-up procedures described below to allow marine mammals and sea turtles to depart the exclusion zone before seismic surveying begins.

Measures to conduct ramp-up procedures during all seismic survey operations, including airgun testing, are as follows:

1. Visually monitor the exclusion zone and adjacent waters for the absence of marine mammals and sea turtles for at least 30 min before initiating ramp-up procedures. If none are detected, you may initiate ramp-up procedures. Do not initiate ramp-up procedures at night or when you cannot visually monitor the exclusion zone for marine mammals and sea turtles if your minimum source level drops below 160 dB re 1 µPa-m (rms) (see measure 5).
2. Initiate ramp-up procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output (dB) and volume (in.^{3}).
3. Continue ramp-up by gradually activating additional airguns over a period of at least 20 min, but no longer than 40 min, until the desired operating level of the airgun array is obtained.
4. Immediately shut down all airguns, ceasing seismic operations at any time a marine mammal or sea turtle is detected entering or within the exclusion zone. However, shutdown would not be required for dolphins approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. After a shutdown, you may recommence seismic operations and ramp-up of airguns only when the exclusion zone has been visually inspected for at least 30 min to ensure the absence of marine mammals and sea turtles.
5. You may reduce the source level of the airgun array, using the same shot interval as the seismic survey, to maintain a minimum source level of 160 dB re 1 µPa-m (rms) for the duration of certain activities. By maintaining the minimum source level, you will not be required to conduct the 30-min visual clearance of the exclusion zone before ramping back up to full output. Activities that are appropriate for maintaining the minimum source level are (1) all turns between transect lines, when a survey using the full array is being conducted immediately prior to the turn and will be resumed immediately after the turn; and (2) unscheduled, unavoidable maintenance of the airgun array that requires the interruption of a survey to shut down the array.

The survey should be resumed immediately after the repairs are completed. There may be other occasions when this practice is appropriate, but use of the minimum source level to avoid the 30-min visual clearance of the exclusion zone is only for events that occur during a survey using the full power array. The minimum sound source level is not to be used to allow a later ramp-up after dark or in conditions when ramp-up would not otherwise be allowed.

PROTECTED SPECIES OBSERVER PROGRAM

Visual Observers

Visual observers who have completed a protected species observer training program as described below are required on all seismic vessels conducting operations in the BA Area. at least two protected species visual observers will be required on watch aboard seismic vessels at all times during daylight hours (dawn to dusk) when seismic operations are being conducted, unless conditions (fog, rain, darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit. Operators may engage trained third party observers, utilize crew members after training as observers, or use a combination of both third party and crew observers. During these observations, the following guidelines shall be followed: (1) other than brief alerts to bridge personnel of maritime hazards, no additional duties may be assigned to the observer during his/her visual observation watch (if conditions warrant more vigilant look-outs when navigating around or near maritime hazards, additional personnel must be used to ensure that watching for protected species remains the primary focus of the on-watch observers); (2) no observer will be allowed more than 4 consecutive hours on watch as a visual observer; (3) a “break” time of no less than 2 hr must be allowed before an observer begins another visual monitoring watch rotation (break time means no assigned observational duties); and (4) no person (crew or third party) on watch as a visual observer will be assigned a combined watch schedule of more than 12 hr in a 24-hr period. Due to the concentration and diligence required during visual observation watches, operators who choose to use trained crew members in these positions may select only those crew members who demonstrate willingness as well as ability to perform these duties.

Training

All visual observers must have completed a protected species observer training course. The BOEM will not sanction particular trainers or training programs. However, basic training criteria have been established and must be adhered to by any entity that offers observer training. Operators may utilize observers trained by third parties, may send crew for training conducted by third parties, or may develop their own training program. All training programs offering to fulfill the observer training requirement must (1) furnish to BOEM a course information packet that includes the name and qualifications (i.e., experience, training completed, or educational background) of the instructor(s), the course outline or syllabus, and course reference material; (2) furnish each trainee with a document stating successful completion of the course; and (3) provide BOEM with names, affiliations, and dates of course completion of trainees.

The training course must include the following elements:

I. Brief overview of the MMPA and the ESA as they relate to seismic acquisition and protection of marine mammals and sea turtles in the Atlantic Ocean.

II. Brief overview of seismic acquisition operations.

III. Overview of seismic mitigation measures and the protected species observer program.

IV. Discussion of the role and responsibilities of the protected species observer, including
   a) Legal requirements (why you are here and what you do);
   b) Professional behavior (code of conduct);
   c) Integrity;
   d) Authority of protected species observer to call for shutdown of seismic acquisition operations;

e) Assigned duties;
 1) What can be asked of the observer;
 2) What cannot be asked of the observer; and
f) Reporting of violations and coercion;

V. Identification of Atlantic marine mammals and sea turtles.
VI. Cues and search methods for locating marine mammals and sea turtles.
VII. Data collection and reporting requirements:
 a) Forms and reports to BOEM via email on the 1st and 15th of each month; and
 b) Marine mammal or sea turtle in exclusion zone/shutdown report within 24 hr.

Visual Monitoring Methods

The observers on duty will look for marine mammals and sea turtles using the naked eye and hand-held binoculars provided by the seismic vessel operator. The observers will stand watch in a suitable location that will not interfere with navigation or operation of the vessel and that affords the observers an optimal view of the sea surface. The observers will provide 360º coverage surrounding the seismic vessel and adjust their positions appropriately to ensure adequate coverage of the entire area. These observations must be consistent, diligent, and free of distractions for the duration of the watch.

Visual monitoring will begin no less than 30 min prior to the beginning of ramp-up and continue until seismic operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, darkness). If a marine mammal or sea turtle is observed, the observer should note and monitor the position (including latitude/longitude of the vessel and relative bearing and estimated distance to the animal) until the animal dives or moves out of visual range of the observer. Make sure you continue to observe for additional animals that may surface in the area, as often there are numerous animals that may surface at varying time intervals. At any time a marine mammal or sea turtle is observed within the exclusion zone, whether due to the animal's movement, the vessel's movement, or because the animal surfaced inside the exclusion zone, the observer will call for the immediate shutdown of the seismic operation, including airgun firing (the vessel may continue on its course but all airgun discharges must cease). However, shutdown would not be required for dolphins approaching the vessel or towed equipment at a speed and vector that indicates voluntary approach to bow-ride or chase towed equipment. The vessel operator must comply immediately with such a call by an on-watch visual observer. Any disagreement or discussion should occur only after shutdown. After a shutdown, when no marine mammals or sea turtles are sighted for at least a 30-min period, ramp-up of the source array may begin. Ramp-up cannot begin unless conditions allow the sea surface to be visually inspected for marine mammals and sea turtles for 30 min prior to commencement of ramp-up (unless the method described in the section entitled "Experimental Passive Acoustic Monitoring" is used). Thus, ramp-up cannot begin after dark or in conditions that prohibit visual inspection (fog, rain, etc.) of the exclusion zone. Any shutdown due to a marine mammal or sea turtle sighting within the exclusion zone must be followed by a 30-min all-clear period and then a standard, full ramp-up. Any shutdown for other reasons, including, but not limited to, mechanical or electronic failure, resulting in the cessation of the sound source for a period greater than 20 min, must also be followed by full ramp-up procedures. In recognition of occasional, short periods of the cessation of airgun firing for a variety of reasons, periods of airgun silence **not exceeding 20 min** in duration will not require ramp-up for the resumption of seismic operations if (1) visual surveys are continued diligently throughout the silent period (requiring daylight and reasonable sighting conditions), and (2) no marine mammals or sea turtles are observed in the exclusion zone. If marine mammals or sea turtles are observed in the exclusion zone during the short silent period, resumption of seismic survey operations must be preceded by ramp-up.

REPORTING

The importance of accurate and complete reporting of the results of the mitigation measures cannot be overstated. Only through diligent and careful reporting can BOEM, and subsequently the NMFS, determine the need for and effectiveness of mitigation measures. Information on observer effort and seismic operations is as important as animal sighting and behavior data. In order to accommodate various vessels' bridge practices and preferences, vessel operators and observers may design data reporting forms in whatever format they deem convenient and appropriate. Alternatively, observers or vessel operators may adopt the United Kingdom's JNCC forms (available at their website, http://www.jncc.gov.uk). At a minimum, the following items should be recorded and included in reports to the BOEM:

<u>Observer Effort Report</u>: Prepared for each day during which seismic acquisition operations are conducted. Furnish an observer effort report to BOEM on the 1st and the 15th of each month that includes

- Vessel name;
- Observers' names and affiliations;
- Survey type (e.g., site, 3D, 4D);
- BOEM Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys");
- Date;
- Time and latitude/longitude when daily visual survey began;
- Time and latitude/longitude when daily visual survey ended; and
- Average environmental conditions while on visual survey, including
  - Wind speed and direction;
  - Sea state (glassy, slight, choppy, rough, or Beaufort scale);
  - Swell (low, medium, high, or swell height in meters); and
  - Overall visibility (poor, moderate, good).

<u>Survey Report</u>: Prepared for each day during which seismic acquisition operations are conducted and the airguns are being discharged. Furnish a survey report to BOEM on the 1st and the 15th of each month during which operations are being conducted that includes

- Vessel name;
- Survey type (e.g., site, 3D, 4D);
- BOEM Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys");
- Date;
- Time pre-ramp-up survey begins;
- What marine mammals and sea turtles were seen during pre-ramp-up survey?
- Time ramp-up begins;
- Were marine mammals seen during ramp-up?
- Time airgun array is operating at the desired intensity;
- What marine mammals and sea turtles were seen during survey?
- If marine mammals were seen, was any action taken (i.e., survey delayed, guns shut down)?
- Reason that marine mammals might not have been seen (e.g., swell, glare, fog); and
- Time airgun array stops firing.

<u>Sighting Report</u>: Prepared for each sighting of a marine mammal or sea turtle made during seismic acquisition operations. Furnish a sighting report to BOEM on the 1st and the 15th of each month during which operations are being conducted that includes

- Vessel name;
- Survey type (e.g., site, 3D, 4D);
- BOEM Permit Number (for "off-lease seismic surveys") or OCS Lease Number (for "on-lease seismic surveys");
- Date;
- Time;
- Watch status (Were you on watch or was this sighting made opportunistically by you or someone else?);
- Observer or person who made the sighting;
- Latitude/longitude of vessel;
- Bearing of vessel;
- Bearing and estimated range to animal(s) at first sighting;

- Water depth (meters);
- Species (or identification to lowest possible taxonomic level);
- Certainty of identification (sure, most likely, best guess);
- Total number of animals;
- Number of juveniles;
- Description (as many distinguishing features as possible of each individual seen, including length, shape, color and pattern, scars or marks, shape and size of dorsal fin, shape of head, and blow characteristics);
- Direction of animal's travel – compass direction;
- Direction of animal's travel – related to the vessel (drawing preferably);
- Behavior (as explicit and detailed as possible; note any observed changes in behavior);
- Activity of vessel;
- Airguns firing? (yes or no); and
- Closest distance (meters) to animals from center of airgun or airgun array (whether firing or not).

Note: If this sighting was of a marine mammal or sea turtle within the exclusion zone that resulted in a shutdown of the airguns, include in the sighting report the observed behavior of the animal(s) before shutdown, the observed behavior following shutdown (specifically noting any change in behavior), and the length of time between shutdown and subsequent ramp-up to resume the seismic survey (note if seismic survey was not resumed as soon as possible following shutdown). Send this report to BOEM **within 24 hr of the shutdown**. These sightings should also be included in the first regular semi-monthly report following the incident.

Additional information, important points, and comments are encouraged. All reports will be submitted to BOEM on the 1st and the 15th of each month (with one exception noted above). Forms should be scanned (or data typed) and sent via email to the BOEM.

Please note that these marine mammal and sea turtle reports are in addition to any reports required as a condition of the geophysical permit.

BOREHOLE SEISMIC SURVEYS

Borehole seismic surveys differ from surface seismic surveys in a number of ways, including the use of much smaller airgun arrays, having an average survey time of 12-24 hr, utilizing a sound source that is not usually moving at 7.4-9.3 km/hr (4-5 kn), and requiring the capability of moving the receiver in the borehole between shots. Due to these differences, the following altered mitigations apply only to borehole seismic surveys:

- During daylight hours, when visual observations of the exclusion zone are being performed as required in this protocol, borehole seismic operations will not be required to ramp-up for shutdowns of 30 min or less in duration, as long as no marine mammals or sea turtles are observed in the exclusion zone during the shutdown. If a marine mammal or sea turtle is sighted in the exclusion zone, ramp-up is required and may begin only after visual surveys confirm that the exclusion zone has been clear for 30 min.
- During nighttime or when conditions prohibit visual observation of the exclusion zone, ramp-up will not be required for shutdowns of 20 min or less in duration. For borehole seismic surveys that utilize passive acoustics during nighttime and periods of poor visibility, ramp-up is not required for shutdowns of 30 min or less.
- Nighttime or poor visibility ramp-up is allowed only when passive acoustics are used to ensure that no marine mammals are present in the exclusion zone (as for all other seismic surveys). Operators are strongly encouraged to acquire the survey in daylight hours when possible.

- Protected species observers must be used during daylight hours, as required in this protocol, and may be stationed either on the source boat or on the associated drilling rig or platform if a clear view of the sea surface in the exclusion zone and adjacent waters is available.
- All other mitigations and provisions for seismic surveys as set forth in this protocol will apply to borehole seismic surveys.
- Reports should reference OCS Lease Number, Area/Block and Borehole Number.

EXPERIMENTAL PASSIVE ACOUSTIC MONITORING

Whales are very vocal marine mammals, and periods of silence are usually short and most often occur when these animals are at the surface and may be detected by visual observers. However, whales are at the greatest risk of potential injury from seismic airguns when they are submerged and under the airgun array. Passive acoustic monitoring appears to be very effective at detecting submerged and diving sperm whales, and some other marine mammal species, when they are not detectable by visual observation. The BOEM strongly encourages operators to participate in an experimental program by including passive acoustic monitoring as part of the protected species observer program. Inclusion of passive acoustic monitoring does **not** relieve an operator of any of the mitigations (including visual observations) in this protocol **with the following exception**: Monitoring for whales with a passive acoustic array by an observer proficient in its use will allow ramp-up and the subsequent start of a seismic survey during times of reduced visibility (darkness, fog, rain, etc.) when such ramp-up otherwise would not be permitted using only visual observers. If passive acoustic monitoring is used, an assessment must be included of the usefulness, effectiveness, and problems encountered with the use of that method of marine mammal detection in the reports described in this protocol. A description of the passive acoustic system, the software used, and the monitoring plan should also be reported to BOEM at the beginning of its use.