NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title:	Biological Opinion on the Bureau of Ocean Energy Management's Issuance of Five Oil and Gas Permits for Geological and Geophysical Seismic Surveys off the Atlantic Coast of the United States, and the National Marine Fisheries Services' Issuance of Associated Incidental Harassment Authorizations
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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat they depend on. Section 7(a)(2) of the ESA requires Federal agencies to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Federal agencies must do so in consultation with the National Marine Fisheries Service (NMFS) for actions that may affect species listed as threatened or endangered or critical habitat designated for such species under Section 4 of the ESA that are under NMFS jurisdiction (50 C.F.R. §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concurs with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If incidental take is expected and certain conditions are met, section 7(b)(4) requires NMFS to provide an incidental take statement that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts and terms and conditions to implement the reasonable and prudent measures.

This ESA section 7 consultation considers the Bureau of Ocean Energy Management's (BOEM) proposed issuance of permits to five companies to conduct geophysical surveys in support of oil- and gas-related activities in BOEM's Mid-and South Atlantic Planning Areas. Since ESA-listed marine mammals are expected to be incidentally harassed during the proposed surveys, this consultation also considers NMFS, Office of Protected Resources, Permits and Conservation Division's proposed issuance of five incidental harassment authorizations (IHAs) to those companies pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) (16 §1361 et seq.). BOEM's sister agency, the Bureau of Safety and Environmental Enforcement (BSEE), provides regulatory oversight and enforces compliance with monitoring and mitigation measures for oil and gas operations. As various monitoring and mitigation measures are proposed for each geophysical surveys (see Conservation Measures in Section 3.7), BSEE participated in this consultation as the agency with inspection and enforcement authority for operations under the proposed BOEM permits. Consequently, the action agencies for this consultation are BOEM, BSEE and the NMFS' Permits and Conservation Division. The consulting agency is NMFS' Office of Protected Resources, Endangered Species Act Interagency Cooperation Division.

This formal consultation, biological opinion (opinion), and incidental take statement, were completed by NMFS' Office of Protected Resources, Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we") in accordance with section 7(a)(2) & (4) and 7(b) of the ESA (16 U.S.C. §1536 (a)(2)), associated implementing regulations (50 C.F.R. §402), and agency policy and guidance.

This document represents NMFS' biological opinion on the effects of the proposed action on Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus,* Carolina, Chesapeake Bay, New York Bight, and South Atlantic Distinct Population Segments [DPSs]), giant manta rays (*Manta birostris*), oceanic whitetip sharks (*Carcharhinus longimanus*), hawksbill sea turtles (*Eretmochelys imbricata*), blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), North Atlantic right whales (*Eubalaena glacialis*), sei whales (*Balaenoptera borealis*), sperm whales (*Physeter macrocephalus*), green sea turtles (*Chelonia mydas*, North Atlantic DPS), Kemp's ridley sea turtles (*Lepidochelys kempii*), leatherback sea turtles (*Dermochelys coriacea*), loggerhead sea turtles (*Caretta caretta*, Northwest Atlantic Ocean DPS), and designated critical habitat for Atlantic sturgeon (Carolina, Chesapeake Bay, Gulf of Maine, New York Bight, and South Atlantic DPSs), loggerhead sea turtles (Northwest Atlantic Ocean DPS), and North Atlantic right whales. A complete record of this consultation is on file at NMFS' Office of Protected Resources in Silver Spring, Maryland.

1.1 Background and Consultation History

This opinion is based on information provided in the five geological and geophysical (G&G) companies' IHA applications; NMFS' Permits and Conservation Division's proposed IHAs, associated Federal Register Notice (82 FR 26244), and request for consultation and associated documents; BOEM's 2014 Programmatic Environmental Impact Statement (PEIS) for G&G activities in the Mid-Atlantic and South Atlantic Planning Areas (BOEM 2014a) and their request for consultation and associated documents; correspondence and discussions with BOEM, BSEE, and NMFS' Permits and Conservation Division; previous biological opinions for similar activities including our 2013 programmatic opinion on BOEM's G&G activities in the Mid-Atlantic and South Atlantic Planning Areas (NMFS 2013b); and the best scientific and commercial data available from the literature. Our communication regarding this consultation is summarized as follows:

On July 19, 2013, NMFS issued its biological opinion to BOEM and BSEE analyzing BOEM's proposed authorization of G&G activities in support of its oil and gas, renewable energy, and marine minerals programs in the Mid- and South Atlantic Planning Areas from 2013 through 2020 (NMFS 2013b). These G&G activities included various types of seismic and high-resolution geophysical surveys in addition to geological subsurface sampling.

On October 16, 2015, BOEM requested reinitiation of consultation since there were a number of species proposed and listed and critical habitat proposed and designated since issuance of the opinion in 2013. Because new information on marine mammal density estimates had also become available, the reinitiated consultation would also consider the relevance of those new estimates for marine mammal species affected by BOEM's oil and gas, renewable energy, and marine minerals programs. From November 2015 through December 2016, NMFS and BOEM worked with Geographic Information System experts and others to determine reliable methods to compare the new density estimates to the ones used in the 2013 consultation. This 2013 reinitiated programmatic consultation is still ongoing with BOEM and BSEE.

The proposed action for this consultation involves only the issuance of five BOEM permits and the associated five NMFS IHAs. On November 3, 2017, BOEM requested initiation of formal consultation on their proposal to issue five permits to authorize private applicants to conduct geophysical surveys within their Mid- and South Atlantic Planning Areas in support of oil- and gas-related activities. Their request was later supplemented with an Atlantic Permit Specific Supplemental Information document on November 30, 2017 (APSSI, BOEM 2017a). To allow for timely processing of the proposed permits, which are considered a subset of the activities that fall under our 2013 reinitiated programmatic consultation, we are conducting a separate consultation to capture the effects of the proposed permits while the 2013 reinitiation is ongoing. Formal consultation on these five permits was formally initiated with BOEM on November 30, 2017, but discussion with BOEM have been ongoing. On June 5, 2017, the Permits and Conservation Division requested formal consultation on their proposed issuance of five IHAs for the same G&G companies seeking BOEM permits. The IHAs would authorize incidental harassment of marine mammals (both ESA-listed and non-ESA-listed) that may occur as a result of the proposed geophysical surveys. The Permits and Conservation Division's request was supplemented with a Federal Register Notice detailing the proposed IHAs. Formal consultation on the five IHAs was initiated with the Permits and Conservation Division on June 28, 2017.

On January 25, 2018, we provided a draft of this opinion to BOEM, BSEE, and the Permits and Conservation Division for their review and requested that they complete their review by February 8, 2018. In addition, the Permits and Conservation Division provided the draft opinion to three G&G companies that requested and were granted applicant status, ION, CGG, and TGS, and similarly requested they complete their review by February 8, 2018. We received comments on the draft opinion from BOEM and BSEE on February 8, 2018. On this date, the Permits and Conservation Division also provided us comments from ION, CGG, and TGS and informed us they needed additional time to complete their review of the draft opinion. The Permits and Conservation Division subsequently provided comments on the draft opinion on February 12, 2018. All comments received on the draft opinion were considered in formulating this final opinion.

On March 6, 2018, BOEM informed us they intend to update their proposed seismic survey protocols and vessel strike avoidance measures and requested our assistance in doing so. As result, we met with BOEM and the Permits and Conservation Division on March 9, 2018, to begin working with BOEM to update Appendices C and D of this opinion to align BOEM's seismic survey protocols and vessel strike avoidance measures with the measures proposed by the Permits and Conservation Division. These appendices were completed on May 7, 2018.

On March 15, 2018, the Permits and Conservation Division informed us that they reconsidered their exposure analysis, and now propose to authorize several takes of fin whales in the form of auditory injury. Prior to this, no takes by auditory injury of fin whales were expected or proposed for authorization. As a result, this opinion was updated to fully analyze this change in the proposed action.

On May 7, 2018, BOEM informed us that Spectrum was considering modifying their proposed tracklines due to a voluntary collaborative effort between Spectrum and TGS. On May 8, 2018, we discussed possible changes to Spectrum's tracklines with the Permits and Conservation Division. The Permits and Conservation Division informed us they were aware that Spectrum and TGS were considering a collaboration, which could result in the removal of some of Spectrum's tracklines, but did not have any official request from Spectrum to modify their proposed survey tracklines at that time. On May 21, 2018, BOEM provided us new maps showing possible modifications to TGS's and Spectrum's tracklines, and requested information on how these possible modifications would affect consultation. We informed BOEM that we would need to evaluate the proposed changes. At that time, the Permits and Conservation Division still did not have an official request from TGS or Spectrum to modify their proposed tracklines.

Per our request, on May 24, 2018, BOEM provide geospatial files for the possible TGS and Spectrum trackline modifications. On June 1, 2018, we met with BOEM, the Permits and Conservation Division, NOAA's Office of General Counsel, the U.S. Department of Interior, Office of the Solicitor, TGS and their legal counsel, and Spectrum to discuss possible changes to TGS's and Spectrum's tracklines. We informed BOEM and the Permits and Conservation Division that if TGS and Spectrum intend to modify their tracklines, and BOEM subsequently proposes to permit the modified tracklines and the Permits and Conservation Division subsequently proposes to authorize take of marine mammals associated with the modified tracklines, we would require an official request from each action agency detailing the changes to the proposed action and any associated change in effects to ESA-listed species and designated critical habitat.

On June 1, 2018, TGS informed us and the Permits and Conservation Division that they did not wish to modify their proposed tracklines. On June 4, 2018, Spectrum officially requested to modify the tracklines associated with their proposed BOEM permit and IHA. In their requests to BOEM and the Permits and Conservation Division, which we were included on, Spectrum provided updated maps and geospatial files for the modified tracklines. On June 26, 2018, BOEM and the Permits and Conservation Division provided updated modified trackline maps and geospatial files for Spectrum that adhere to the Coastal Zone Management Act agreement between Spectrum and South Carolina, which was not taken into account in the maps and geospatial files initially provided by Spectrum on June 4, 2018. The final proposed changes include rotating Spectrum's previous trackline grid by approximately five degrees, trimming lines from various proposed closure areas (see Section 3.7.1 below), removing lines that were duplicated by TGS's tracklines, and shifting some lines to be centered on TGS's tracklines (see Section 9.3 and Figure 32) . The revised total amount of trackline consists of 13,766 kilometers (km), which is a decrease of approximately 36 percent in the total amount of trackline from the originally proposed survey (see Table 1 below).

On July 2, 2018, the Permits and Conservation Division provided an official request to change their proposed action based on the changes to Spectrum's tracklines, along with the Permits and Conservation Division's conclusion regarding any change in effects to ESA-listed species and/or designated critical habitat. On July 19, 2018, BOEM provided an official request to change their proposed action in which they detailed the changes to Spectrum's tracklines associated the proposed BOEM permit, along with BOEM's conclusion regarding any change in effects to ESA-listed species and/or designated critical habitat.

On September 6, 2018, the Permits and Conservation Division informed us they received NOAA policy's review of the draft final IHAs, which included several possible changes to the required mitigation measures. On October 12, 2018, the Permits and Conservation Division informed us of two minor changes to the IHAs: 1) in lieu of the North Atlantic right whale closure, applicants would be allowed to develop a plan for NMFS approval that would be sufficient to achieve comparable protection, and 2) the distance for shutdowns for North Atlantic right whales, large whales accompanied by calf, or aggregations of six or more large whales was changed from 2 km to 1.5 km (see Section 3.7 for further discussion of these minor changes). On October 16, 2018, BOEM requested we update Appendix C (BOEM's Atlantic Airgun Seismic Survey Protocols) so that it aligns with these minor changes in the IHAs.

2 The Assessment Framework

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with and with the assistance of NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat.

"*Jeopardize the continued existence of*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species." 50 C.F.R. §402.02.

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological

features essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

The final designations of critical habitat for green, leatherback, and loggerhead sea turtles used the term primary constituent element (PCEs) or essential features. The new critical habitat regulations [81 FR 7414 (Feb. 11, 2016)] replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this opinion, we use the term PBFs to mean PCEs or essential features, as appropriate for the specific critical habitat.

An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3), *Interrelated and Interdependent Actions* (Section 4), *Stressors Created by the Proposed Action* (Section 5), and *Action Area* (Section 6): We describe the proposed action, identify any interrelated and interdependent actions, detail the stressors that are likely to result from the proposed action, and define the spatial extent of the action area based on the projected geographic reach of the effects of the action and the stressors it is likely to create.

Species and Designated Critical Habitat that may be Affected (Section 7): We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time and evaluate the status of those species and habitat. In this section, we also identify any species and designated critical habitat not likely to be adversely affected (Section 7.1).

Environmental Baseline (Section 8): We describe the environmental baseline in the action area including past and present impacts of federal, state, or private actions and other human activities in the action area, anticipated impacts of proposed federal projects that have already undergone formal or early section 7 consultation, and impacts of state or private actions that are contemporaneous with the consultation in process.

Effects of the Action (Section 9): The effects section considers the direct and indirect effects of the proposed action on listed species and designated critical habitat together with those of any interrelated, interdependent activities that will be added to the environmental baseline. We evaluate the effects of the stressors that are likely to result from the proposed action, incorporate any measures that will be taken to minimize exposure and adverse effects to ESA-listed resources that may result from the stressors, determine the number (and age or life stage, and gender, if possible) of ESA-listed individuals that are likely to be exposed to the stressors, and identify the populations or subpopulations to which those individuals belong. We also consider whether the action "may affect" designated critical habitat. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the action may affect designated critical habitat. This is our response analysis. We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis. The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat.

Cumulative Effects (Section 10): Cumulative effects are the effects to ESA-listed species and designated critical habitat of future state or private activities that are reasonably certain to occur within the action area (50 C.F.R. §402.02). Effects from future federal actions that are unrelated to the proposed action are not considered because they require separate ESA section 7 compliance.

Integration and Synthesis (Section 11): In this section, we integrate the preceding analyses to summarize the consequences to ESA-listed species and designated critical habitat under NMFS' jurisdiction.

Conclusion (Section 12); With full consideration of the status of the species and the designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on PBFs when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify a reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (50 C.F.R. §402.14).

In addition, we include an incidental take statement (Section 13) that specifies the impact of the take, non-discretionary reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary conservation recommendations (Section 14) that may be implemented by the action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 15; 50 C.F.R. §402.16).

To comply with our obligation to use the best scientific and commercial data available, we collected information through searches of *Google Scholar*, *Web of Science,* literature cited sections of peer reviewed articles, species listing documentation, and reports published by government and private entities. This opinion is based on our review and analysis of various information sources, including:

- The five G&G companies' IHA applications
- NMFS' Permits and Conservation Division's proposed IHAs and associated Federal Register Notice (82 FR 26244)
- NMFS' Permits and Conservation Division's request to initiate formal consultation and associated documents on the five IHAs
- BOEM's 2014 Programmatic Environmental Impact Statement (PEIS) for G&G activities in the Mid-Atlantic and South Atlantic Planning Areas (BOEM 2014a)
- BOEM's request to initiate formal consultation and associated documents on the five specific permit applications to conduct G&G surveys in support of oil and gas activities (BOEM 2017a).
- Biological opinions on similar activities including our 2013 programmatic opinion on BOEM's G&G activities in the Mid-Atlantic and South Atlantic Planning Areas (NMFS 2013b)
- The best available scientific information from published and unpublished literature such as commercial and government reports and peer-reviewed scientific literature
- Expert opinion in ESA-listed species biology

These resources were used to identify information relevant to the potential stressors and responses of ESA-listed species and designated critical habitat under NMFS' jurisdiction that may be affected by the proposed action to draw conclusions on risks the action may pose to the continued existence of these species and the value of designated critical habitat for the conservation of ESA-listed species.

3 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies. The action for this consultation, as described in the requests for initiation of consultation, is issuance of five BOEM permits and the associated five NMFS IHAs. For purposes of efficiency and consistency, and as requested by BOEM and NMFS' Permits and Conservation Division, this consultation and opinion considers all five permits and IHAs together given the similarity and timing of the actions. Thus, this is a "batched" rather than a "programmatic" or "single action" consultation. Importantly, we do not anticipate synergistic impacts between and among the permits and IHAs given time and location across a broad geographic area in the mid- and South Atlantic. Nonetheless, we consider the action to encompass the issuance of all five permits and IHAs, and thus, evaluate their combined effect as a whole (50 C.F.R. §402.14(c)(6)).

BOEM, under the authority of the Outer Continental Shelf Lands Act, as amended, permits and regulates the geophysical activities that are the subject of this consultation within federal waters. For the Atlantic, BOEM's jurisdiction includes waters between three nautical miles (the limit for state waters) and at least 200 nautical miles [the limit of the U.S. Exclusive Economic Zone (U.S. EEZ)]. Some portions of the geophysical surveys, however, may occur seaward of the U.S. EEZ, beyond BOEM's authority. Activities that occur outside of the U.S. EEZ that are implemented by U.S. citizens (as defined by the MMPA) are still subject to the MMPA and actions authorized, funded or carried out by any federal agency, including the issuance of MMPA authorizations, are subject to section 7 of the ESA. Thus, the geophysical surveys that would occur outside of the U.S. EEZ were also considered during this consultation since they still require MMPA authorization.

Although there has been one completed aerial gravity survey in 2015 on the Atlantic Outer Continental Shelf (OCS), there is currently no oil and gas exploration, development, or production activity, and there are no active oil and gas leases and have not been any since 1983. However, BOEM's 2019–2024 Draft Proposed OCS Oil and Gas Leasing Program (Draft Proposed Program) proposes three lease sales in each of BOEM's Mid-and South Atlantic Planning Areas in 2020, 2022, 2024 (BOEM 2018). The geophysical surveys described below are activities that typically occur prior to leasing, the purpose of which is to map and geologically screen large areas for potential oil and gas deposits. There has been no final decision on the lease sales that will be included in the 2019–2024 Proposed Final Oil and Gas Leasing Program. The Draft Proposed Program is currently the subject of public comment and hearings. Additional steps and many months of analysis are required before a Proposed Final Program will be issued and a final determination on when and where, if at all, any Atlantic lease sales take place.

The following sections describe the geophysical surveys that BOEM proposes to permit and for which the Permits and Conservation Division proposes to issue IHAs. The geophysical survey activities proposed for permitting and IHA authorization take place over the shelf, slope, and abyssal plain at water depths ranging from 50 meters (m) to approximately 6,000 m except for areas governed by time/area closures as discussed in Section 3.7.1 below. Since there are currently no federal leases for potential oil and gas development on the Atlantic OCS, the surveys described in this opinion are considered exploratory activities. Typical exploratory activities include 2-Dimension (2-D) geophysical surveys using seismic airguns to explore and evaluate deep geologic formations. The surveys are designed to cover thousands of square miles or entire geologic basins as a means to geologically screen large areas for potential oil and gas deposits. These surveys may occur within the U.S. EEZ from Delaware to approximately Cape Canaveral, Florida within BOEM's Mid- and South Atlantic planning areas and additional waters on the extended continental shelf (350 nautical miles from shore), except in certain time/area closures. Below, we describe exploratory seismic surveys more generally, and then detail the specific seismic surveys proposed by the five companies that have applied for permits and IHAs. BOEM and the Permits and Conservation Division also propose to condition the permits and IHAs with several conservation measures, much of which the five G&G companies also proposed and included in their IHA applications. Details of these aspects of the proposed action are given in Section 3.7 below.

3.1 Seismic Surveys and Acoustics Background

Seismic surveys are conducted using acoustic sources and receivers that record the returning acoustic signals. The acoustic sources used in seismic surveys consist of airgun arrays while the receivers consist of towed cables with hydrophones encased in plastic tubing called streamers. When an airgun array is activated, an acoustic energy bubble pulse is emitted and reflected or refracted back from the seafloor and subsurface interfaces. These reflected/refracted acoustic signals create pressure fluctuations, which are detected and recorded by the streamers. Data collected by the streamers are then transferred and recorded in the vessel's initial data processing system. A ship, generally 60 to 100 m long, tows both the array and the streamer below the sea surface along a predetermined trackline (Figure 1). A tail buoy marks the end of the gear, allowing the crew to monitor the location and direction of the streamers.

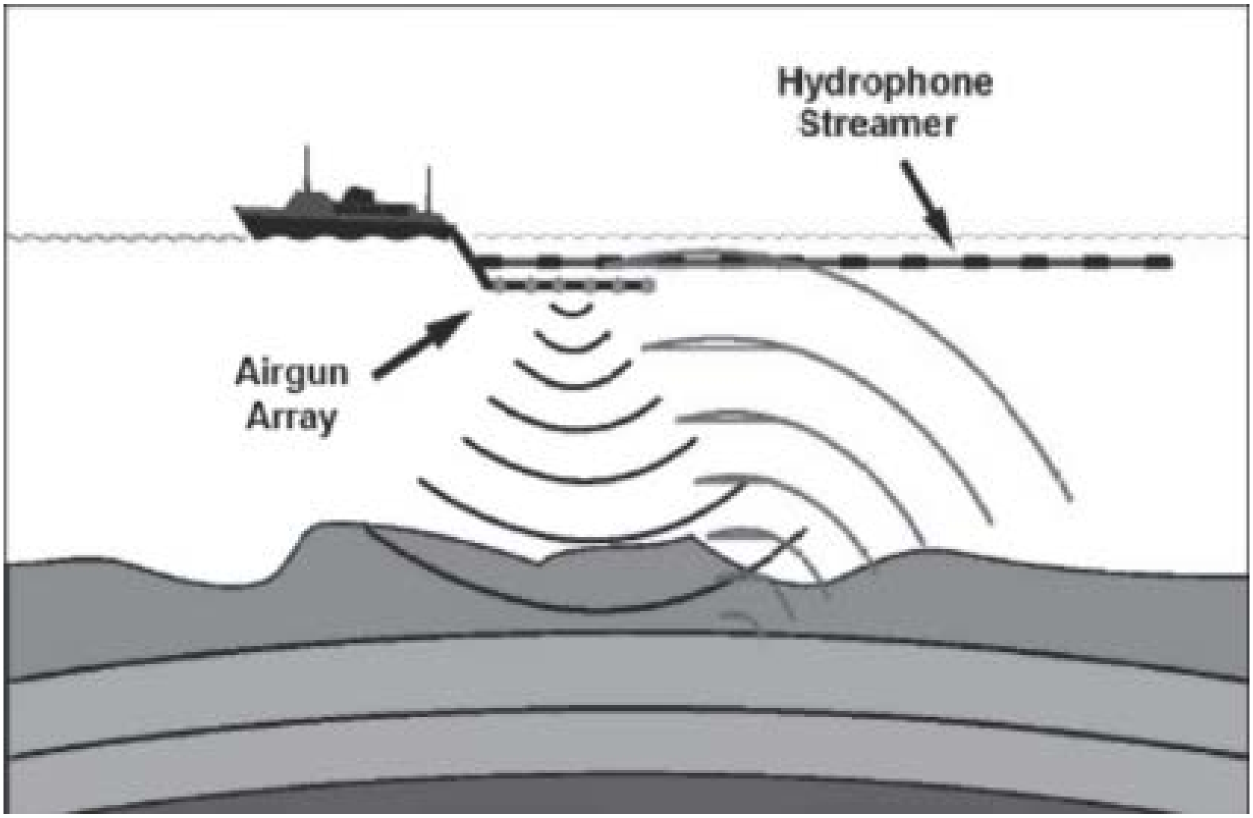

Figure 1: Seismic vessel towing airgun array and hydrophone streamer (BOEM 2014a) .

Based on the requirements of the survey, one or more source vessels with streamers may be employed. Upon reaching the end of the trackline, a vessel can take three or more hours to turn around and start down another trackline. This procedure takes place day and night and may continue for weeks, or months, depending on the size of the survey area. Seismic support vessels (chase and supply vessels) often accompany source vessels and are responsible for operational support and maintenance of safe conditions. Chase vessels maintain safe navigation by informing the source vessel of marine debris, which may pose a risk to deployed gear. Chase vessels also communicate a mariners notice to ensure vessels in the area maintain a safe distance from the deployed seismic equipment. When not performing support functions, the chase vessel cruises about five kilometers (km) in front of the source vessel. Supply vessels support the source vessel by making port calls for fuel, groceries, and general supplies and crew changes. Helicopters can also serve as support by performing crew transfers. Once a survey is completed, all vessels demobilize and return to the nearest suitable port.

Sometimes during seismic acquisition, companies also passively collect information on the gravitational and the magnetic field in the survey area. Gravitational and magnetic data help identify and assess geologic formations. A gravity meter passively measures minute fractional changes of the Earth’s gravitational field and identifies variations in rock density. A magnetometer passively measures the Earth’s magnetic field at a specific point in space and detects surface and subsurface geological anomalies. Both the gravity meter and/or the magnetometer can be towed either from a fixed point on the source vessel's stern or from the airgun array.

To provide context and background relevant for understanding seismic acoustic sources, a brief technical understanding of underwater acoustics is provided below. Further details can be found in 82 FR 26244, from which this information was derived.

Sound from airguns, like all sound, travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the "loudness" of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is one micro Pascal (μPa)), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source decibels relative to 1 μPa, and thus is written as dB re: 1 μPa at 1 m, while the received level is the SPL at the listener's position (i.e., 0 m from the listener) and thus is written as dB re: 1 μPa with no distance.

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Rms is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick 1983). Rms accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re: 1 μPa^2-s) represents the total energy contained within a certain time period and considers both intensity and duration of exposure. For a single pulse (e.g., single airgun shot), it may be written as SEL_{ss}, whereas cumulative sound exposure levels over multiple pulses may be written as SEL_{cum}. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-pk) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately 6 dB higher than peak pressure (Greene 1997).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources). The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Sounds are often considered to fall into one of two general types: impulsive and non-impulsive, which differ in the potential to cause physical effects to animals [see Southall et al. (2007) for in-depth discussion]. Impulsive sound sources produce brief, broadband signals that are atonal transients and occur as isolated events or repeated in some succession. They are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury. Non-impulsive sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous. Some can be transient signals of short duration but without the essential properties of pulses (e.g., rapid rise time). The duration of non-impulsive sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

The seismic airguns proposed for use produce impulsive sounds. Airguns produce sound with energy in a frequency range from about 10 to 2,000 Hz, with most energy radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions (i.e., omnidirectional), but airgun arrays do possess some directionality due to different phase delays between individual gun placement within the array. Airgun arrays are typically tuned to maximize functionality for data acquisition purposes, meaning that sound transmitted in horizontal directions and at higher frequencies is minimized to the extent possible.

In addition to impulsive airgun sounds, the proposed action would produce non-impulsive sounds from vessels and echosounders. Sounds emitted by survey vessels would be low frequency and continuous, but would be widely dispersed in both space and time. In contrast, echosounders generally produce higher frequency, intermittent sounds used to estimate bathymetry, and would be more localized to the vessels from which they are used.

Having broadly described the seismic surveys being proposed and the necessary acoustics background, below we describe the specific seismic surveys proposed by the five companies. While there are similarities between the five surveys, each company has configured its airgun array and survey design to optimize seismic data acquisition for its needs as seen in Table 1. Additional details on each companies proposed surveys can be found in their applications available on NMFS website[1].

[1] https://www.fisheries.noaa.gov/action/incidental-take-authorization-oil-and-gas-industry-geophysical-survey-activity-atlantic

Table 1: Airgun array characteristics and general survey information for each company. Modified from 82 FR 26244.

Company	Location	Effort (km)[2]	Duration (days)[3]	Airgun Array volume (in^3)	Nominal Source Output (Downward, dB re: 1 µPa at 1 m)			Shot Interval (m)	Tow Depth (m)
					0-pk	pk-pk	rms		
ION	Delaware - Northern Florida	13,062	70 acquisition /100 total	6,420	257	263	247[4]	50	10
Spectrum	Delaware - Northern Florida	21,635	165 acquisition /180 total	4,920	266	272	243	25	6-10
TGS	Delaware - Northern Florida	58,300	308 acquisition /365 total	4,808	255	[5]	240	25	7
WesternGeco	Maryland- Northern Florida	27,330	208 acquisition /365 total	5,085	[5]	262	235	37.5	10
CGG	Virginia - Georgia	28,670	155 acquisition /175 total	5,400	[5]	259	243[4]	25	7
BOEM 5,300 in^3 Large Array[6]	--	--	--	5,400	247	[5]	233	n/a	6.5

3.2 ION

BOEM and the Permits and Conservation Division propose to issue a permit and an IHA (each valid for one year), respectively, to ION. ION seeks to conduct a 2-D seismic survey off the U.S. east coast from Delaware to northern Florida (approximately 38.5º N to approximately 27.9º N), and from 30 km from the coast onto the extended continental shelf at more than 600 km from the coast (Figure 2). The survey is planned for July through December and consists of five widely-spaced transect lines (approximately 20 to 190 km apart) roughly parallel to the coast and 14 widely-spaced transect lines (approximately 30 to 220 km apart) in the onshore-offshore direction totaling approximately 13,062 km of data acquisition line. Water depths in the survey area range from 100 m to over 3,000 m. There would be limited additional operations associated with equipment testing, startup, line changes, and repeat coverage of any areas where initial data quality is sub-standard. Therefore, there could be some small amount of use of the acoustic source not accounted for in the total estimated line-km but this activity is difficult to quantify in advance.

The survey would involve one source vessel and one support vessel. The proposed source vessel for use is 72.1 m long, has a cruising speed of 9.5 knots, with a maximum speed of 10 knots. The support vessel would range from 37 to 46 m with a maximum speed of around 12 knots. The source and support vessel would return to port at the same time approximately every 42 days

[2] Effort in km represents what was proposed by the five seismic companies and may not account for any proposed closures that would reduce the overall trackline km.
[3] Duration in days represents what was proposed by the five seismic companies and may not account for any proposed closures that may alter the actual duration.
[4] Value decreased from modeled 0-pk value by minimum 10 dB (Greene 1997).
[5] Values not given; however, SPL (pk-pk) is usually considered to be approximately 6 dB higher than SPL (0-pk) (Greene 1997).
[6] Notional large array characteristics modeled and source characterization outputs from BOEM (2014a) provided for comparison.

(dependent on fuel consumption) for crew change and the taking on of provisions. ION currently projects that four port calls would be required during the project and that each port call would require approximately four days (dependent on distance from port). Even when the source vessel is offshore, the airgun array would not be operating continuously as the average time duration between lines is 13.5 hours.

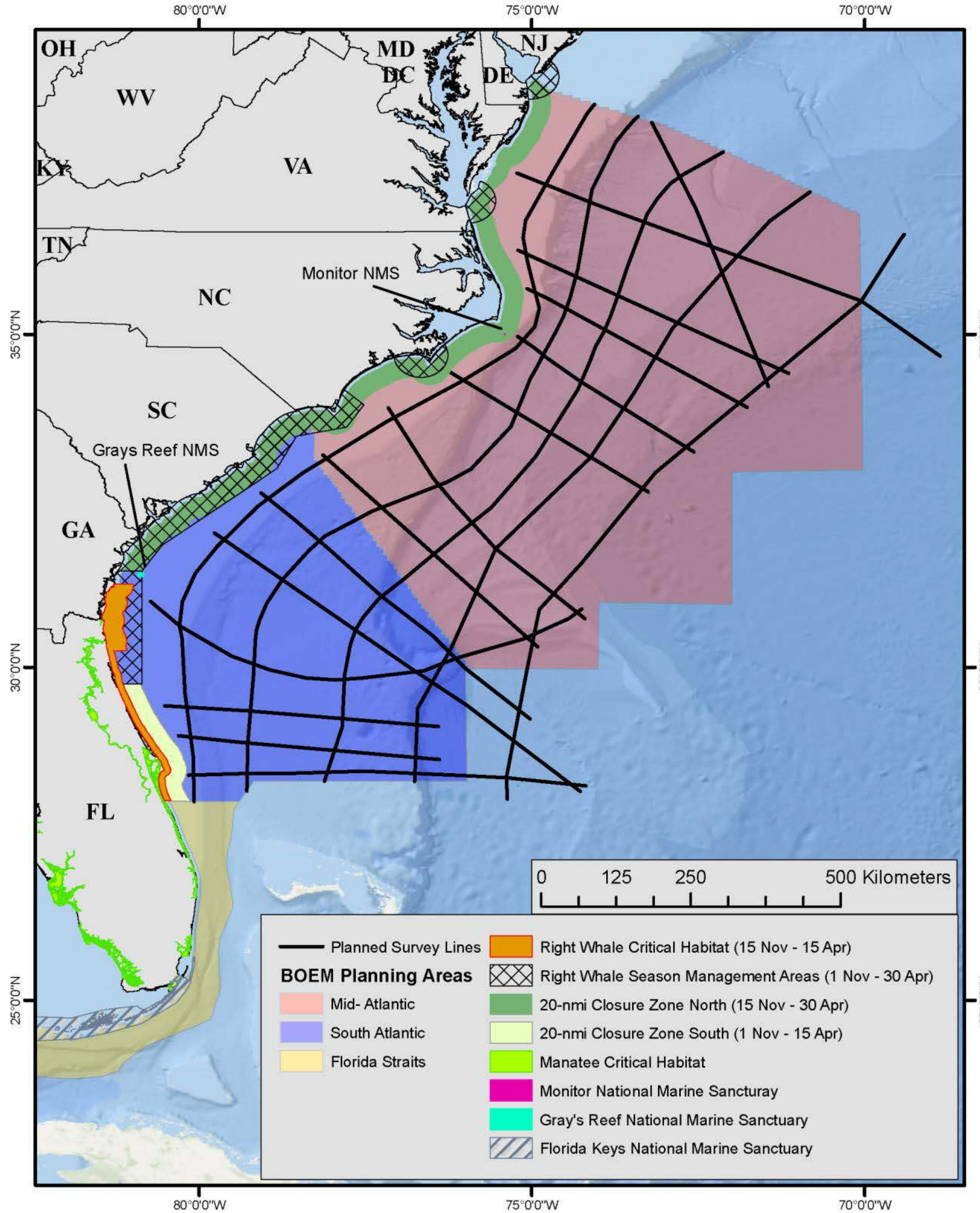

Figure 2. ION survey area showing track lines. Note that the displayed “Right Whale Critical Habitat” is inaccurate based on its recent expansion.

The acoustic source planned for deployment is a 36-airgun array with a total volume of 6,420 cubic inches (Table 1). The airgun array consists of nine airguns on each of four identical linear arrays or "strings". The four airgun strings span an approximate area of 34 by 15.5 m and would be typically towed approximately 50 to 100 m behind the vessel at a 10-m depth. The firing pressure of the array would be 2,000 pounds per square inch. The 36-airgun array would consist of a mixture of Bolt 1500LL airguns (ranging in volume from 300 to 380 cubic inches) and sleeve airguns (ranging in volume from 40 to 150 cubic inches). The airgun array would fire every 50 m or every 20 to 24 seconds, depending on exact vessel speed. When fired, the energy emitted from the airgun array results in a pulse lasting approximately 0.1 seconds. Nominal source levels would be approximately 247 dB re: 1 µPa at 1 m (rms) (Table 1). To record the returning acoustic signals, the source vessel will tow a single hydrophone streamer measuring up to 12 km long. Both the airgun array and the hydrophone streamer would be towed by the vessel at approximately four knots during data acquisition.

ION may also deploy a low-level acoustic pinger system, operating between 50 and 100 kilohertz (kHz) to position the airgun array and streamer. Vessel operators also plan to use standard navigational echosounders (single beam) on both the source vessel and the chase vessel. The vessels would use a Kongsberg EA600 Echosounder. It is single beam, works at 18 kHz, with pulse duration of 6 milliseconds and one pulse every second. We were unable to find the estimate source level of this specific echosounder, but assume it has source levels similar to the navigational echosounders used by other companies [e.g., 180 to 200 dB re: 1 µPa at 1 m (rms), see TGS and WesternGeco below]. Additional equipment on the vessel includes a gravity meter and magnetometer to measure gravity and magnetic fields within the survey area respectively.

3.3 Spectrum

BOEM and the Permits and Conservation Division propose to issue a permit and IHA (each valid for one year), respectively, to Spectrum. Spectrum seeks to conduct a 2-D seismic survey off the U.S. east coast from Delaware to northern Florida (approximately 38.5º N to approximately 27.9º N), extending throughout BOEM's Mid- and South Atlantic OCS planning areas and onto the extended continental shelf. The survey is planned for February through July and would be conducted on an approximately 25 by 32 km grid; grid size may vary to minimize overall survey distance (Figure 3). The closest trackline to shore would be a parallel line approximately 35 km off Cape Hatteras, North Carolina.

The survey would involve one source vessel and one chase vessel. Although the exact vessels have not been determined, we assume the source vessel would fall within the typical range of other source vessels, between 60 and 100 m long, and have a cruising speed of around 9 knots and maximum speed of around 12 knots. The source vessel will remain in the survey area and operate continuously for the duration of the survey. The specific chase vessel that would be used has also not yet been identified, but it is assumed that it would fall within the typical range of other chase vessels, between 35 to 50 m long, and have a cruising speed of around 10 knots and a maximum speed of around 12 knots. The survey plan includes a total of approximately 21,635 km of data acquisition line, including turns and re-surveying due to environmental or technical reasons. Water depths in the survey area range from 30 to 5,410 m.

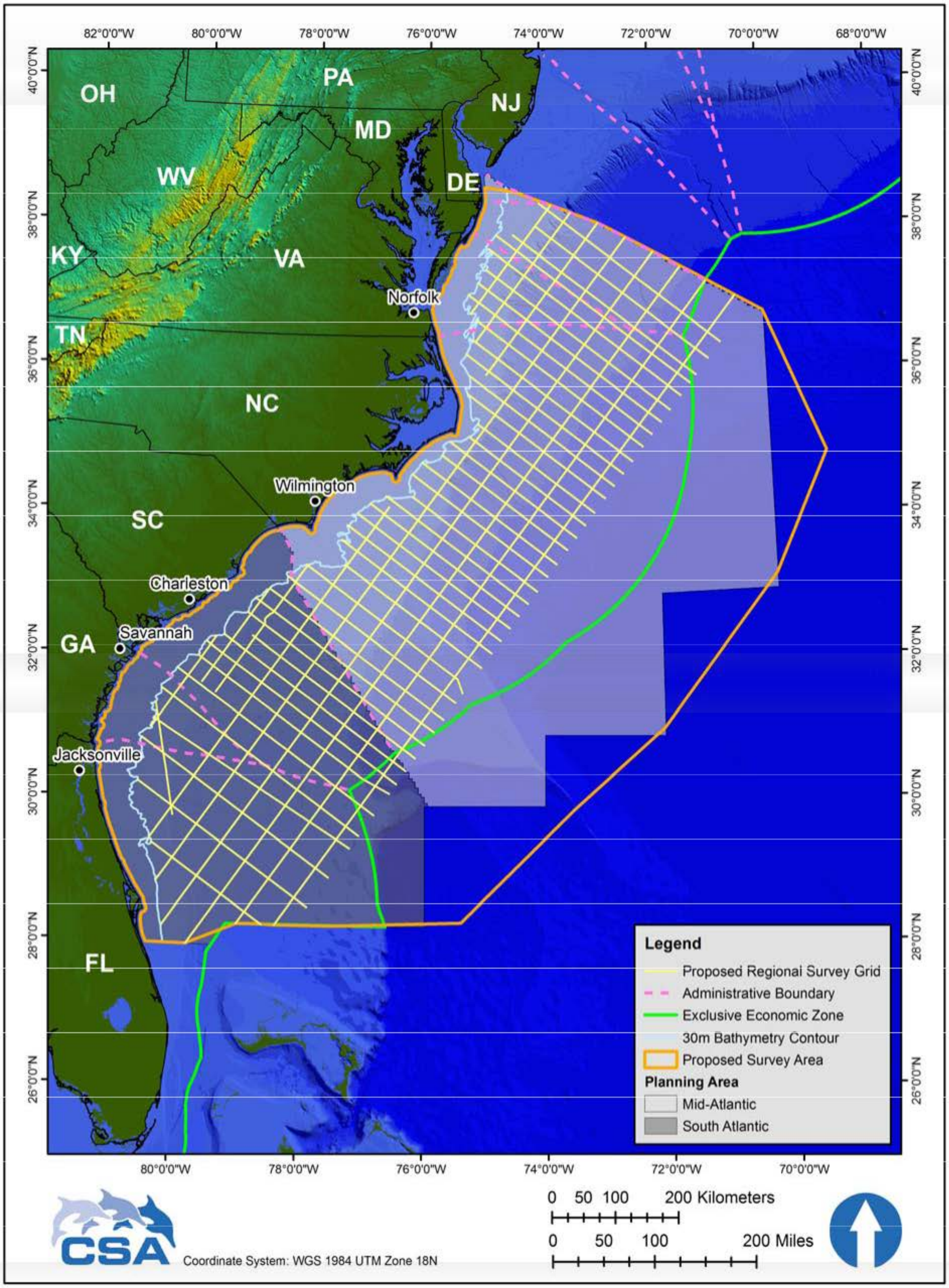

Figure 3. Spectrum survey area showing track lines.

The acoustic source planned for deployment is a 32-airgun array with a total volume of 4,920 cubic inches (Table 1). The 32-airgun array would consist of individual airguns ranging in volume from 50 to 250 cubic inches towed at 6 to 10 m depth. The firing pressure of the array would be 2,000 pounds per square inch. The airguns are configured as four subarrays, each separated by approximately 10 m and consisting of 8 to 10 airguns. Two airguns on each string are held as spares in case of equipment failure. Total array dimensions span 40 by 30 m. The airgun array would fire every 25 m or every 10 seconds, depending on exact vessel speed. Nominal source levels would be approximately 243 dB re: 1 µPa at 1 m (rms) (Table 1). To record the returning acoustic signals, the source vessel would tow a single 12 km hydrophone streamer at 10 to 20 m below the sea surface. The airgun array and the hydrophone streamer would be towed by the vessel at approximately 4 to 5 knots during data acquisition.

Additional equipment on the vessel includes an echosounder for navigation and a magnetometer to measure gravity and magnetic fields within the survey area. The frequency and source level of the echosounder that would be used is not known at this time, but it is assumed it would be similar to those used by other companies (e.g., 180 to 200 dB re: 1 µPa at 1 m (rms), see TGS and WesternGeco below).

3.4 TGS

BOEM and the Permits and Conservation Division propose to issue a permit and an IHA (each valid for one year), respectively, to TGS. TGS seeks to conduct a 2-D seismic survey off the U.S. east coast from Delaware to offshore Cape Canaveral, Florida (approximately 38.5º N to approximately 27.9º N), extending throughout BOEM’s Mid- and South Atlantic OCS planning areas and onto the extended continental shelf.

TGS proposes to use two source vessels operating at least 100 km apart to survey different areas of the project area. Although the exact vessels have not been determined, the source vessel will range in length from 75 to 85 m long and have a cruising speed of 12 knots. The source vessel will remain in the survey area and operate continuously for the duration of the survey. Each source vessel requires an attending chase vessel. The chase vessels would provide logistical support for the source vessel such as protection of deployed survey equipment as well as crew transfers and trips to port for fuel and other supplies. The chase vessels would range in length from 19 to 24 m long and have a maximum cruising speed of 12 knots. TGS may also hire a third vessel to transport fuel and other supplies to the source vessel every three to four weeks as well as helicopters to support crew changes every five weeks. Helicopters may be used to transport crew to and from vessels during crew changes, which occur every five weeks.

The survey plan consists of three contiguous survey grids with differently spaced lines (Figure 4) in water depths ranging from approximately 30 to 5,410 m. Lines would be spaced 100 km apart in approximately the eastern half of the project area and approximately 25 km apart in the western portion of the survey area. A third, more detailed grid (6 to 10 km spacing) would cover the continental shelf drop-off, near the center of the survey area from north to south. The closest trackline to the coast would be 30 km from shore. The survey plan includes a total of 55,133 km of data acquisition line plus an additional 3,167 km of trackline expected for run-in/ramp up and run-out, for a total of 58,300 km. Run-in is approximately 1 km of operating the seismic source at full power before starting a new line to test equipment. Runout is 6 km (half the distance of the acquisition streamer behind the seismic vessel) at which the seismic source is kept at full power beyond the end of a trackline to make sure all data along the trackline are collected by the streamer. There would be limited additional operations associated with equipment testing, startup, line changes, and repeat coverage of any areas where initial data quality is sub-standard.

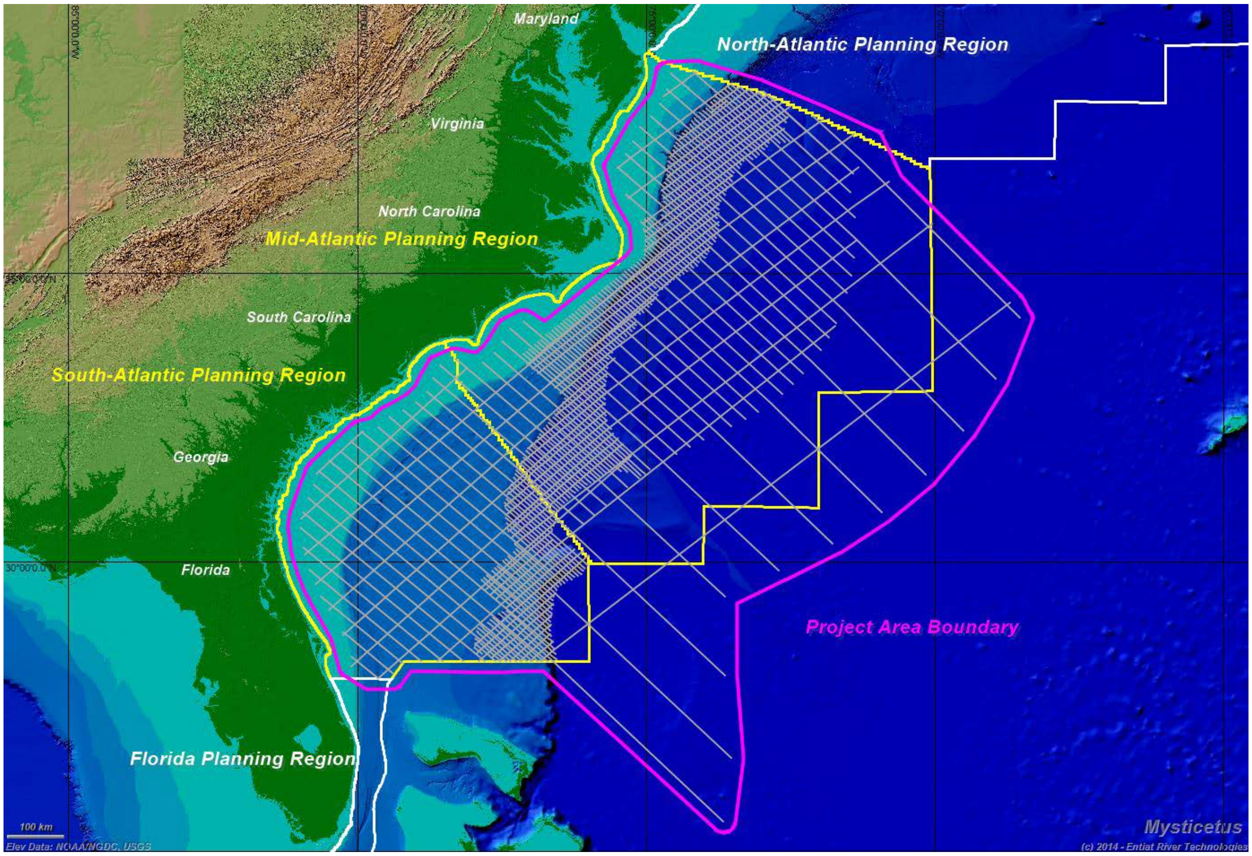

Figure 4. TGS survey area showing track lines. Purple line = TGS project area boundary. Yellow line = BOEM Planning Areas.

Both source vessels would deploy a 48-airgun array with a total volume of 4,808 cubic inches towed behind the vessel at a 6 to 8 m depth (Table 1). However, only 40 individual airguns would be used at any given time, with the remaining airguns held as spares in case of equipment failure. The airgun array consists of Sodera G-gun II airguns ranging in volume from 22 to 250 cubic inches. The airguns would be configured as four identical subarrays, with individual airguns spaced 8 m apart. The airgun array fires every 25 m or every 10 seconds depending on vessel speed. Nominal source levels are estimated to be 240 dB re: 1 µPa at 1 m (rms) (Table 1). To record the returning acoustic signals, each source vessel would tow a single 12-km long hydrophone streamer towed at depths of 8 to 10 m. The airgun arrays and the hydrophone streamers would be towed by the vessel at approximately 4 to 5 knots during data acquisition.

In addition to the airgun array, TGS also intends to employ single beam echosounders, which also emit intermittent acoustic energy pulses, on each of its vessels. These echosounders would be for navigational purposes and not involved in data acquisition. Two echosounders (one emitting high frequencies to assess shallow water depths and the other emitting low frequencies to assess deeper water depths), would be in operation on each vessel. Frequencies for the echosounders would range from 50 to 200 kHz. Each emitted acoustic pulse or "ping" would last 0.25 to 3.60 milliseconds and be repeated up to 750 times per minute. Typical source levels would be 180 to 200 dB re: 1 µPa at 1 m (rms). TGS will also acquire gravity and magnetic data during seismic acquisition.

3.5 WesternGeco

BOEM and the Permits and Conservation Division propose to issue a permit and an IHA (each valid for one year), respectively, to WesternGeco. WesternGeco seeks to conduct a 2-D seismic survey off the U.S. east coast from Maryland to northern Florida (approximately 38.0º N to approximately 30.0º N), extending through the majority of BOEM's Mid- and South Atlantic OCS planning areas (Figure 4). The survey area extends from about 30 km offshore of the southeast coast of Maryland, south to 80 km offshore of St. Augustine, Florida, with limited survey effort (three percent) on the extended continental shelf. The survey plan consists of survey lines spaced 25 km apart in approximately the southwestern third of the project area, and lines spaced approximately 6 km apart in the remainder of the survey area. The closest trackline to the coast would be 30 km. The survey plan includes a total of 26,641 km of data acquisition line, plus an additional 689 km of lines expected for run-in/run-out, for a total of 27,330 km. Water depths in the survey area range from 20 to 4,700 m. There would be limited additional operations associated with equipment testing, startup, and repeat coverage of any areas where initial data quality is sub-standard.

The survey would involve one source vessel approximately 70.5 m in length, as well as two chase vessels and a supply vessel ranging from 40 to 50 m in length. The source vessel would have cruising speed of approximately 9 knots when not collecting data, and a maximum speed of approximately 12 knots. The support vessels would have cruising speeds of approximately 10 knots and maximum speeds of 12 knots. The source vessel would remain in the survey area and operate continuously for the duration of the survey. The supply vessel would transit between the survey vessel and port approximately to provide refueling and re-supply. As with the other surveys, the chase vessels would provide logistical support for the source vessel such as protection of deployed survey equipment as well as crew transfers and trips to port for fuel and other supplies. Crew changes would occur every five weeks via support vessels while supply runs would typically occur every 2.5 weeks and would coincide with the five-week crew changes. WesternGeco does not plan to use helicopters, but if the need arises, they may use a S76 C++ or AW 139.

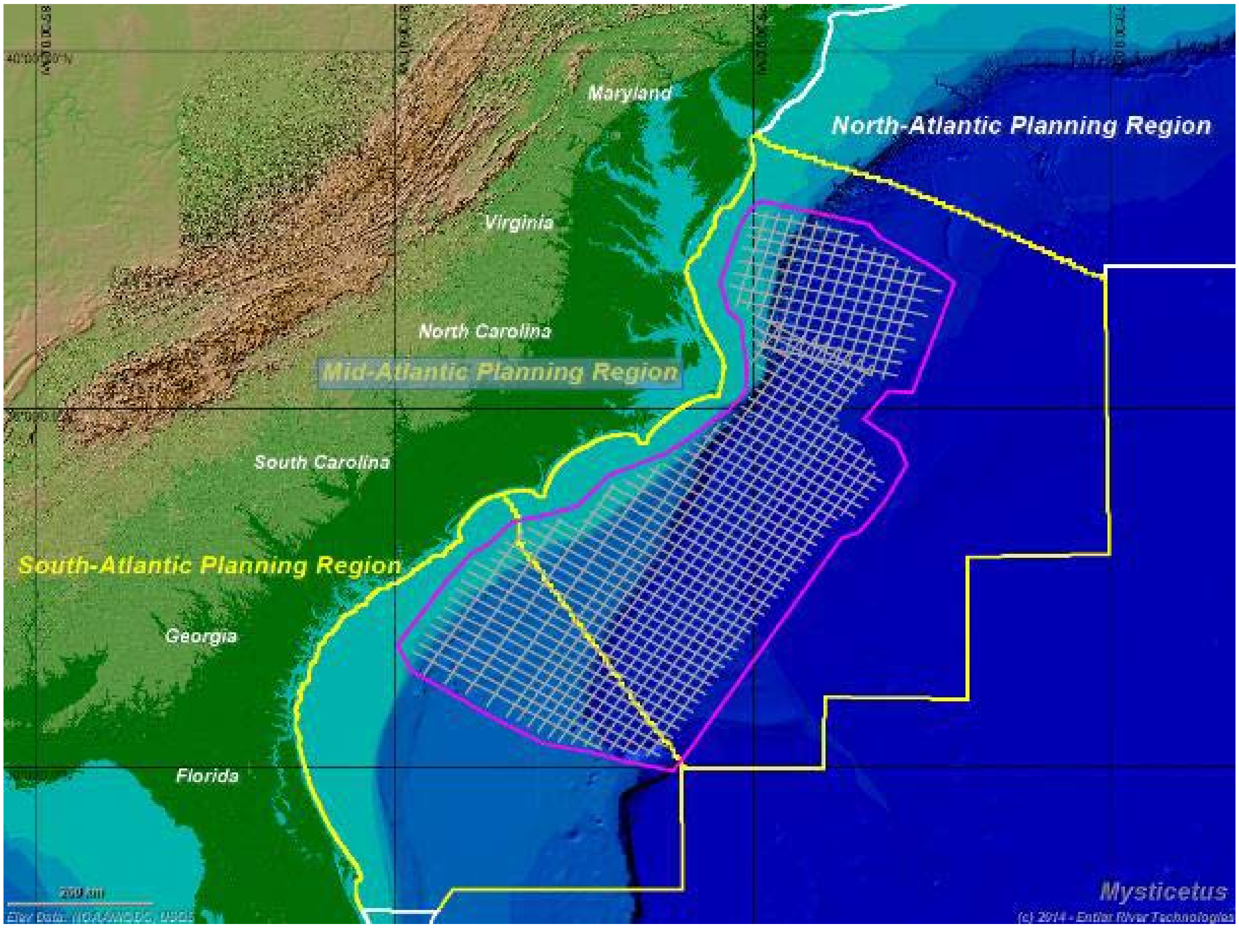

Figure 5. WesternGeco survey area showing track lines. Purple line = TGS project area boundary. Yellow line = BOEM Planning Areas.

The seismic source planned for deployment is a 24-airgun array with a total volume of 5,085 cubic inches towed at a depth of 10 m (Table 1). The 24-airgun array would consist of individual Bolt v5085 airguns. The airguns would be configured as three identical subarrays of eight airguns each with 8 m spacing between strings. The airgun array would fire every 37.5 m (approximately every 16 seconds, depending on vessel speed), with expected transit speed of 4 to 5 knots. Nominal source levels are estimated to be 235 dB re: 1 µPa at 1 m (rms) (Table 1). To record the returning acoustic signal, the source vessel would tow a single 10.5 km hydrophone streamer. Streamer tow depth is expected to vary from 9 to 11 m at the front end (closest to the vessel) to 40 m below the water's surface at the tail end.

WesternGeco would also employ single beam echosounders, which also emit intermittent acoustic energy pulses, on each of its vessels. The echosounders would be for navigational purposes and not involved in data acquisition. A Simrad EA600 echosounder (or equivalent) would operate at high frequencies to assess shallow water depths and at low frequencies to assess deeper water depths. Frequencies for the echosounders would range from 38 to 200 kHz. Each emitted acoustic pulse or "ping" would last from 0.06 to 8 milliseconds depending on water depth. The highest ping rate would be 20 pings per minute, which would occur in shallow water. Typical source levels for echosounders would range from 180 to 200 dB re: 1 μPa at 1 m (rms). WesternGeco will also acquire gravity and magnetic data during seismic acquisition.

3.6 CGG

BOEM and the Permits and Conservation Division propose to issue a permit and an IHA (each valid for one year), respectively, to CGG. CGG seeks to conduct a 2-D seismic survey off the U.S. east coast from Virginia to Georgia (approximately 37º N to approximately 30º N). The survey would extend through the majority of BOEM's Mid- and South Atlantic OCS planning areas (Figure 6) and onto the extended continental shelf. The survey would consist of tracklines in a 20 by 20 km orthogonal grid, with the closest trackline occurring approximately 80 km from the coast. The survey plan includes a total of 28,670 km of data acquisition line, in water depths ranging from 100 to 5,000 m. There would be limited additional operations associated with equipment testing, startup, and repeat coverage of any areas where initial data quality is sub-standard.

The survey would involve one source vessel, as well as two support vessels. CGG expects to acquire a seismic research vessel approximately 100 m in length, and have a typical cruising speed of 8 knots. The vessel would remain in the survey area and operate continuously for the duration of the survey. The two support vessels would be approximately 50 m in length, average speeds of approximately 10 knots, and used during the proposed survey for operational support and maintenance of safe conditions. One vessel, the chase vessel, would be used to maintain safe navigation by informing the seismic research vessel of marine debris, which may pose a risk to deployed gear. The chase vessel would also communicate a mariners notice to ensure vessels in the area maintain a safe distance from the deployed seismic equipment. The second vessel, the supply vessel, would be present in the survey area to supply fuel, groceries, and general supplies to the seismic research vessel. Both support vessels would make port calls to re-supply and change its onboard crew.

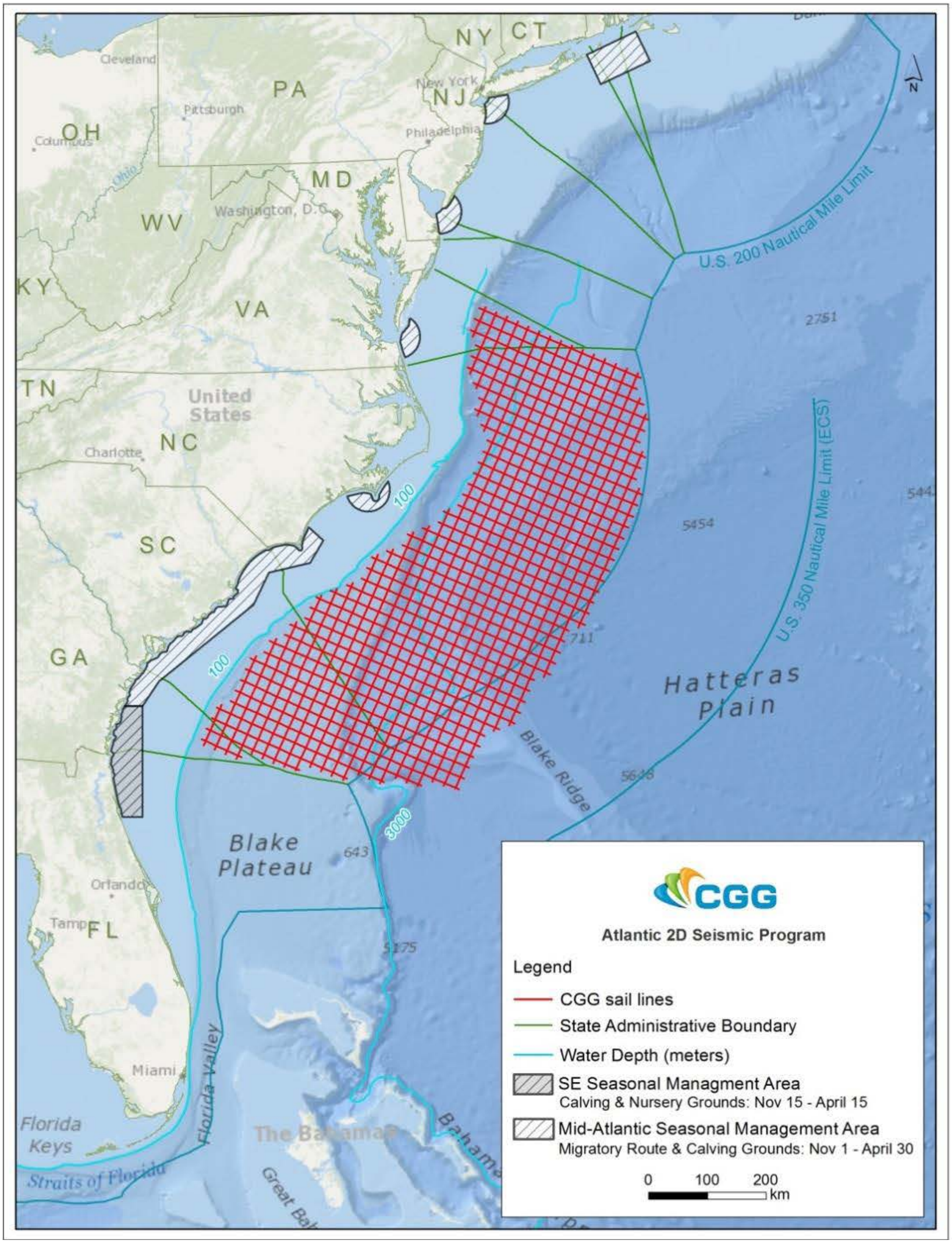

Figure 6. CGG survey area showing track lines.

The seismic source planned for deployment is a 36-airgun array with a total volume of 5,400 cubic inches towed at a depth of 7 m (Table 1). The 36-airgun array would consist of individual Bolt 1900/1500 airguns. The airguns would be configured as four subarrays of nine airguns each, with total dimensions of 24 m width by 16.5 m length and 6 m separation between strings. The airgun array would fire every 25 m (approximately every 16 seconds, depending on vessel speed), with expected transit speed between 3.7 and 5.4 knots. Nominal source levels would be approximately 243 dB re: 1 μPa at 1 m (rms) (Table 1). To record the returning acoustic signal, the source vessel would tow a single 10 to 12 km hydrophone streamer. CGG will also acquire gravity and magnetic data during seismic acquisition.

3.7 Conservation Measures

Several aspects of the action, as proposed by BOEM or the Permits and Conservation Division, are designed to minimize adverse effects (i.e., exposure and response) to ESA-listed species that may result from the proposed seismic surveys. Many of these conservation measures were also proposed by the five G&G companies in their IHA applications. These conservation measures are components of the proposed action and their effects were therefore considered in this consultation. They include restricting airgun surveys in certain time-area closures, specific seismic airgun survey protocols, and vessel strike avoidance and marine debris awareness measures. These measures were directly incorporated into our effects analysis (Section 9). For example, the originally proposed sperm whale take estimates specified in the Federal Register notice associated with the draft IHAs (82 FR 26244) were recalculated during consultation to account for the proposed sperm whale closures detailed below. We anticipate that all of these conservation measures will be implemented and effective as BOEM and NMFS' Permits and Conservation Division will incorporate these measures into their permits and IHAs respectively. As such, our conclusion regarding whether or not the proposed action is likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat is contingent upon the implementation of these conservation measures.

Below we provide an overview of the conservation measures associated with the proposed action as they pertain to ESA-listed species. This information was derived from the proposed IHAs and associated Federal Register Notice [see section titled *Proposed Mitigation* in Appendix A (82 FR 26244)], as modified on the basis of public comment received on the proposals, BOEM's 2014 PEIS for the Mid-Atlantic and South Atlantic Planning Areas and their record of decision [see section titled *4. Additional Protected Measures Included in Alternative B* in BOEM (2014a) Appendix C and decision in BOEM (2014b)], supplemental information on the Coastal Zone Management Act (CZMA) conditions that the G&G companies agreed to with the relevant states, provided to us by BOEM (Appendix B), and BOEM and BSEE's Notices to Lessees for the Gulf of Mexico, which were used to develop BOEM's seismic survey protocols, and vessel strike avoidance and marine debris awareness measures (Appendix C-E). In addition, our understanding of these conservation measures was further refined with BOEM, BSEE, and the Permits and Conservation Division over the course of consultation.

3.7.1 Time/Area Closures

To minimize exposure of marine mammals to seismic survey activities, the Permits and Conservation Division propose several areas that would be closed to seismic survey activities, in some cases only at certain times of the year (Table 2, Figure 7). In addition, BOEM proposes to condition the permits with restrictions regarding when and where seismic activity can occur within and near National Marine Sanctuaries. Finally, as part of coordination with the states under the CZMA, ION, Spectrum, TGS, and CGG have agreed to several additional closures that will be incorporated into the BOEM permits. While these closures were designed to protect a variety of ESA-listed and non-ESA-listed species, as well as coastal resources more generally, here we focus our discussion on how they would likely protect ESA-listed species.

Table 2: Proposed area closures for the five seismic surveys.

Closure Name	Proposing Entity	Location	Duration	Companies	Target ESA-listed Species
North Atlantic Right Whale Closure	NMFS' Permits and Conservation Division (IHA)	Within 90 km of coast from Delaware to Cape Canaveral, Florida	Nov. 1 – Apr. 30	All	North Atlantic right whales
Coastal Closure	NMFS' Permits and Conservation Division (IHA)	Within 30 km of the coast from Delaware to Cape Canaveral, Florida (fully encompasses BOEM (2014a) Brevard County Sea Turtle Closure)	Year-round	All[7]	None[8]
Area #1: Deepwater Canyon Closure	NMFS' Permits and Conservation Division (IHA)	Hatteras Traverse Canyon bounded by Hatteras Ridge	Year-round	All	None[9]
Area #2: Deepwater Canyon Closure	NMFS' Permits and Conservation Division (IHA)	Hatteras Canyon	Year-round	All	Sperm whales
Area #3: Deepwater Canyon Closure	NMFS' Permits and Conservation Division (IHA)	Deepwater valley system fed by a series of canyons and gullies incising the slope between Hendrickson and Baltimore Canyons	Year-round	All	Sperm whales
Area #4: Hatteras and North Closure	NMFS' Permits and Conservation Division (IHA)	Shelf break off Cape Hatteras and to the north through Delaware, including slope waters around "The Point"	Jan. 1 – Mar. 31	All	Sperm whales
Gray's Reef National Marine Sanctuary Closure	BOEM (Permit)	Off Georgia coast	Year-round	All[10]	None[11]
Monitor National Marine Sanctuary Closure	BOEM (Permit)	Off the North Carolina coast	Year-round	All[10]	None[11]
Maryland Closure	G&G Companies & States (CZMA)	Within 232 km of the coastline	Apr. 15 – Nov. 15	Spectrum	None[12]

[7] Applies to all companies but only TGS proposed tracklines within this closure area.
[8] Designed to protect coastal bottlenose dolphins.
[9] Designed to protect beaked whales.
[10] Applies to all companies but several of the companies do not propose tracklines within these areas.
[11] Designed to protect sanctuary resources.
[12] Designed to protect coastal natural resources generally.

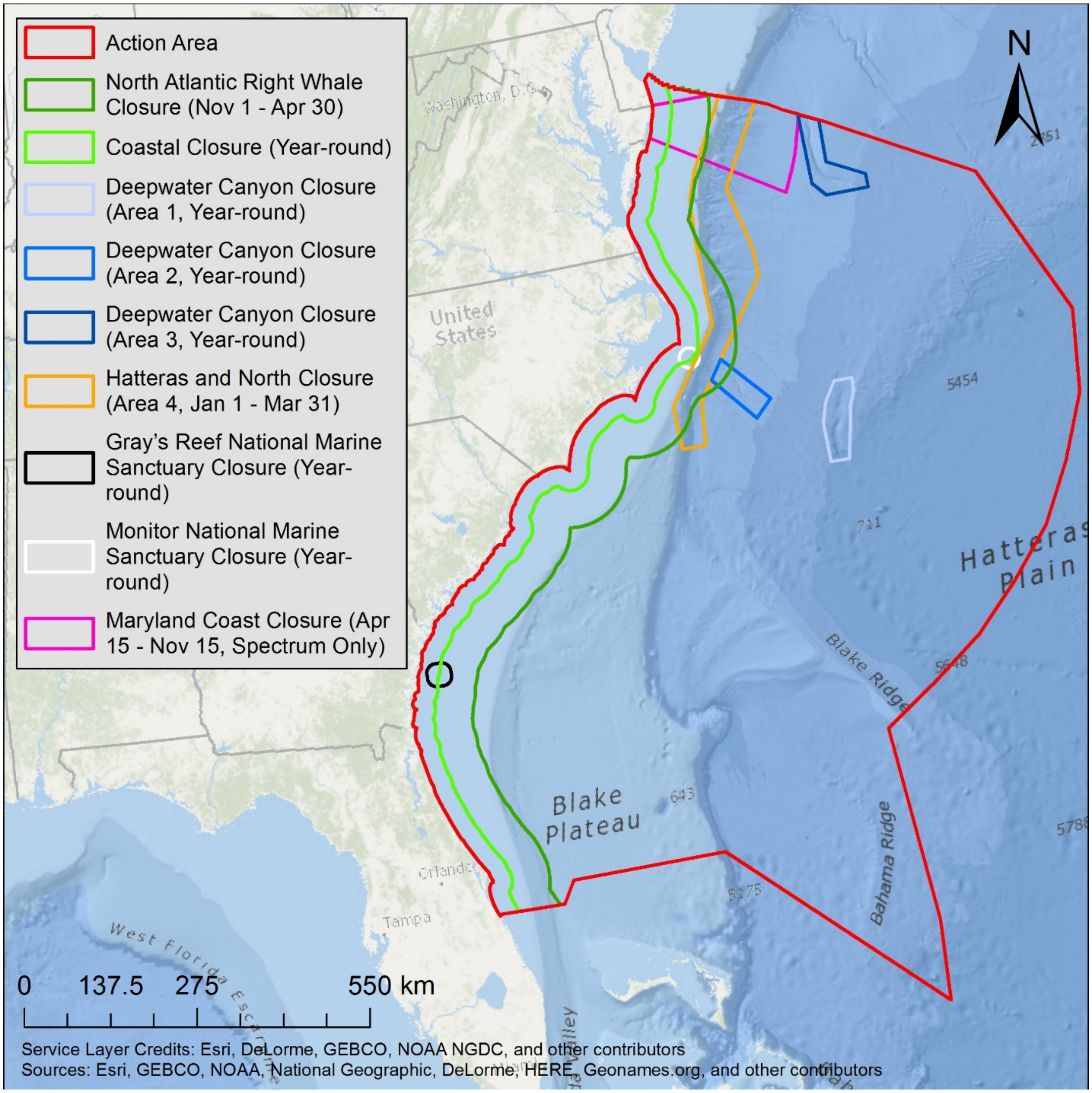

Figure 7. Map of proposed time/area closures. Note that when closures overlap, the more restrictive closure applies (e.g., Area 2 year-round closure supersedes the seasonal North Atlantic right whale closure where the two overlap).

3.7.1.1 North Atlantic Right Whale Closure

The Permits and Conservation Division proposes to prohibit surveys within and in proximity to areas used by North Atlantic right whales during important life history stages to limit the exposure of North Atlantic right whales to seismic survey activities. As detailed below, the proposed closure area combines and expands upon established Seasonal Management Areas

(SMAs), Dynamic Management Areas (DMAs), and designated North Atlantic right whale critical habitat within the action area (Figure 8).

In 2008, NMFS established several SMAs along the U.S. east coast at certain times of the year in which regulations require all vessels 65 feet (19.8 m) or longer to travel at 10 knots or less (78 FR 73726). In the mid-Atlantic region, these SMAs are active from November 1 to April 30 annually, while in the south-Atlantic region SMAs are active from November 15 to April 15 annually. In addition to these SMAs, NMFS periodically establishes voluntary 15-day (can be extended) DMAs in areas where North Atlantic right whales have been observed outside of established SMAs, requesting mariners to avoid these areas and/or reduce speeds to 10 knots or less when transiting through. DMAs have previously been established within the action area, and may be established within the action area during the course of the five proposed seismic surveys. Finally, in 2016 NMFS expanded designated North Atlantic right whale critical habitat within the action area (Unit #2), as described below in Section 7.2.3.5. During the breeding season (designated as November 15 to April 15 annually), North Atlantic right whales are expected to be found within this designated critical habitat, which aligns with recent modelling efforts (Krzystan et al. 2018)

The proposed North Atlantic right whale closure is a coastal strip that would encompass all SMAs and designated critical habitat within the action area, and be extended out to 90 km offshore. As such, it would also fully encompass the 37 km coastal North Atlantic right whale closure proposed by BOEM in their 2014 PEIS and associated record of decision [see section titled *4.1. Expanded Time-Area Closure for North Atlantic Right Whales* in BOEM (2014a) Appendix C and decision in BOEM (2014b)].

Originally, the Permits and Conservation Division proposed this closure to extend to 47 km offshore. However, given the current status of North Atlantic right whales (Section 7.2.3.4), during consultation we expressed concern regarding the amount of exposure of North Atlantic right whales across all five proposed IHAs. The Permits and Conservation Division agreed with our concern and considered whether additional data were available to support further protective measures for North Atlantic right whales. Based on recently updated North Atlantic right whale habitat density modelling that showed a strong relationship between North Atlantic right whale abundance and distance to shore out to approximately 80 km in the action area [(Roberts et al. 2017), relationship previously estimated out to approximately 50 km in Roberts et al. (2016)], the Permits and Conservation Division proposed to expand the original 47 km offshore closure to 90 km offshore closure. These updated 2017 Roberts et al. North Atlantic right whale models were a vast improvement over the Roberts et al. (2016) models in that they incorporated approximately 72 times as many sightings of North Atlantic right whales within the action area and were informed by passive acoustic monitoring data (Davis et al. 2017; Roberts et al. 2016; Roberts et al. 2017).

The expanded closure is expected to drastically reduce the number of North Atlantic right whales that would be exposed to seismic activity across all five IHAs and permits. As in the originally proposed North Atlantic right whale closure, this updated closure includes a 10 km standoff distance (80 km closure, plus a 10 km buffer for a total closure of 90 km) designed to prevent sound levels that would be expected to produce a behavioral disturbance (160 dB re: 1 μPa at 1 m (rms) or higher) from entering the area based on BOEM's 2014 PEIS modelling efforts (BOEM 2014a, 82 FR 26244). In addition, any areas NMFS establishes as DMAs within the action area would be closed to seismic surveys, including a 10-km buffer around the DMAs. In the North Atlantic right whale closure area, surveys would not be permitted from November 1 through April 30 in order to protect right whales, especially calving females, when they are expected to be most abundant in the area (Krzystan et al. 2018). No survey operations would be allowed in DMAs when they are active.

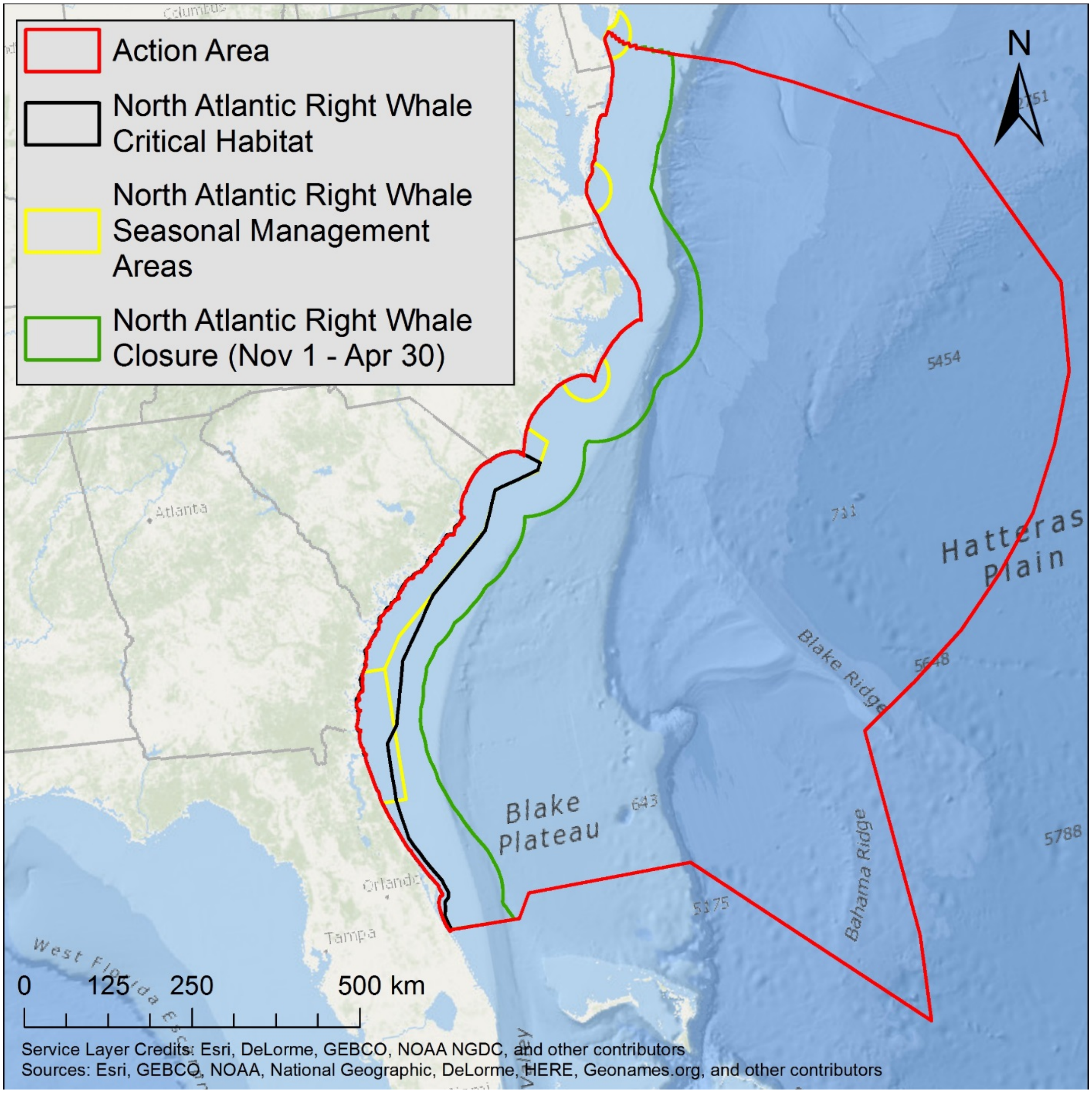

Figure 8. Map of proposed North Atlantic right whale closure. Seismic surveys would be prohibited within the proposed closure from November 1 through April 30 annually.

As discussed in Section 1.1, in lieu of this closure, applicants would be allowed to develop and submit a monitoring and mitigation plan for the Permits and Conservation's approval that would be sufficient to achieve comparable protection for North Atlantic right whales. If approved, applicants would be required to maintain a minimum coastal standoff distance of 47 km from November through April while operating in adherence with the approved plan from 47 through 80 km offshore (10-km buffer would be protected by the plan). In the event that any applicant submits such a plan for review and potential approval, the Permits and Conservation Division would engage us for evaluation of the plan to ensure it is within the scope of the analyses in this opinion.

3.7.1.2 Coastal Closure

The Permits and Conservation Division also proposes a coastal closure designed to protect non-ESA-listed coastal stocks of bottlenose dolphins. While this closure is not specifically designed to protect ESA-listed species, we evaluate it here as part of the conservation measures being proposed with the proposed action since it is likely to provide additional protection for ESA-listed resources.

The Permits and Conservation Division's proposed coastal closure would prohibit seismic survey activity within 30 km of the coast within the Mid- and South Atlantic Planning Areas at any time of the year (Figure 9). As mentioned above, the intent of this closure is to provide additional protection for non-ESA-listed coastal stocks of bottlenose dolphins, but it would also protect coastal North Atlantic right whales, Atlantic sturgeon (all DPSs), ESA-listed sea turtles in their coastal habitat, and some of the designated critical habitat for loggerhead turtles. In fact, this closure completely encompasses the sea turtle closure proposed by BOEM in their 2014 PEIS for the Mid- and South Atlantic Planning Areas (BOEM 2014a; BOEM 2014b), and as such, this specific BOEM sea turtle closure is not further discussed in this opinion. The proposed coastal closure is applicable to all companies; however, Spectrum, CGG, and WesternGeco do not propose to conduct surveys within 30 km of the coast, and following the publication of the proposed IHAs in the Federal Register, ION eliminated all proposed tracklines within 30 km of the coast.

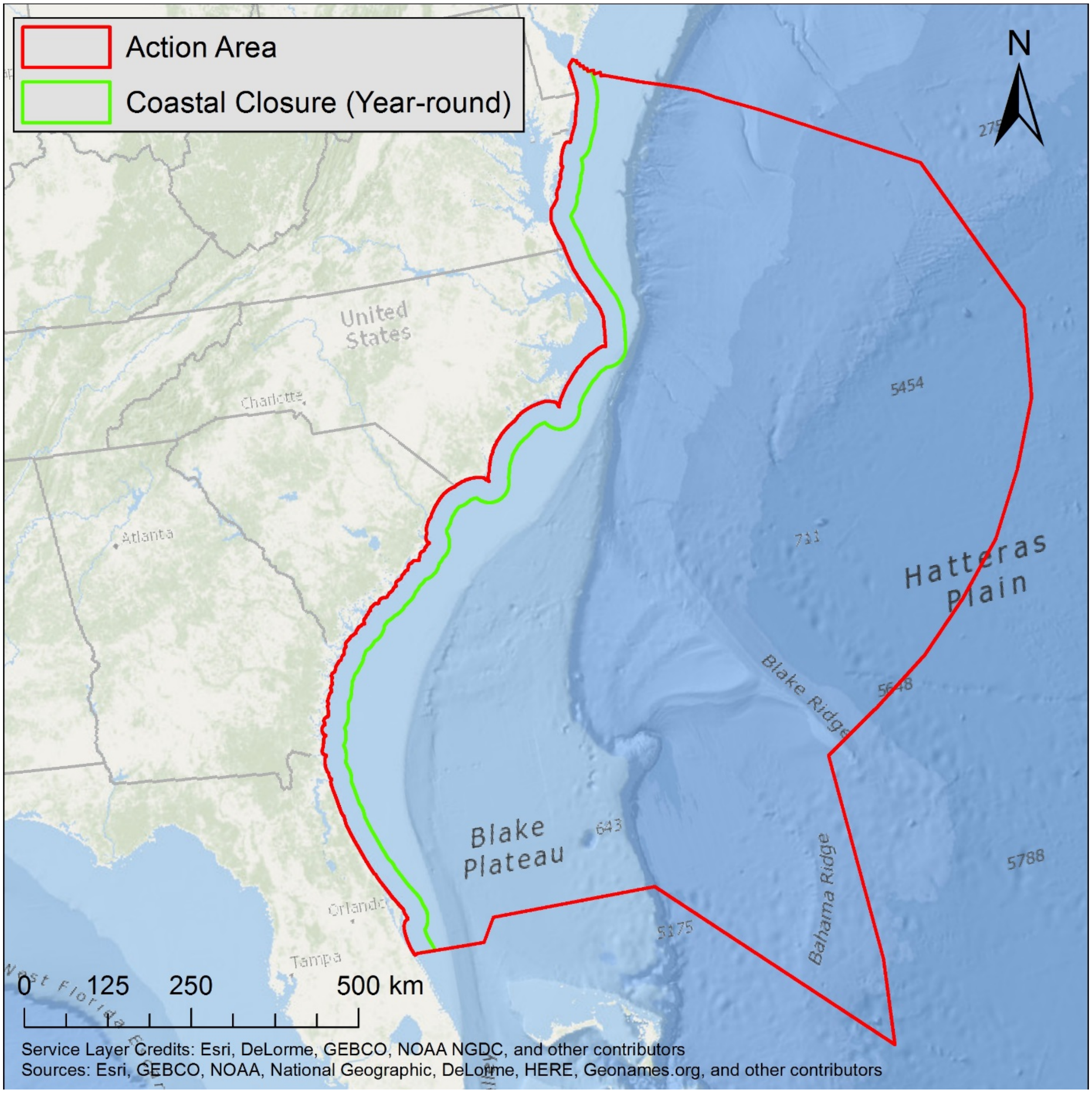

Figure 9. Map of proposed 30-kilometer coastal closure. Seismic surveys would be prohibited within the coastal closure year-round.

3.7.1.3 Sperm Whales

As further detailed below, the Permits and Conservation Division also propose additional time/area closures on survey effort to avoid or limit exposure of sperm whales to seismic survey activities. As above with the North Atlantic right whale closure, a 10-km buffer was added to these closures (fully included in final closures described here, not in addition to) to prevent sound from airguns entering the closed areas at levels of 160 dB re: 1 μPa at 1 m (rms) or higher based on the acoustic modelling performed for BOEM's 2014 PEIS (BOEM 2014a, 82 FR 26244).

Deepwater Canyon Closures

Three deep-water canyon areas (Areas 1-3, Figure 10) are proposed to be closed to seismic surveys year-round. Although these areas may be protective of additional non-ESA-listed species, two of these areas (Area 2 and 3) are expected to be particularly beneficial for sperm whales. Based on survey effort, this condition would be applicable to all five companies.

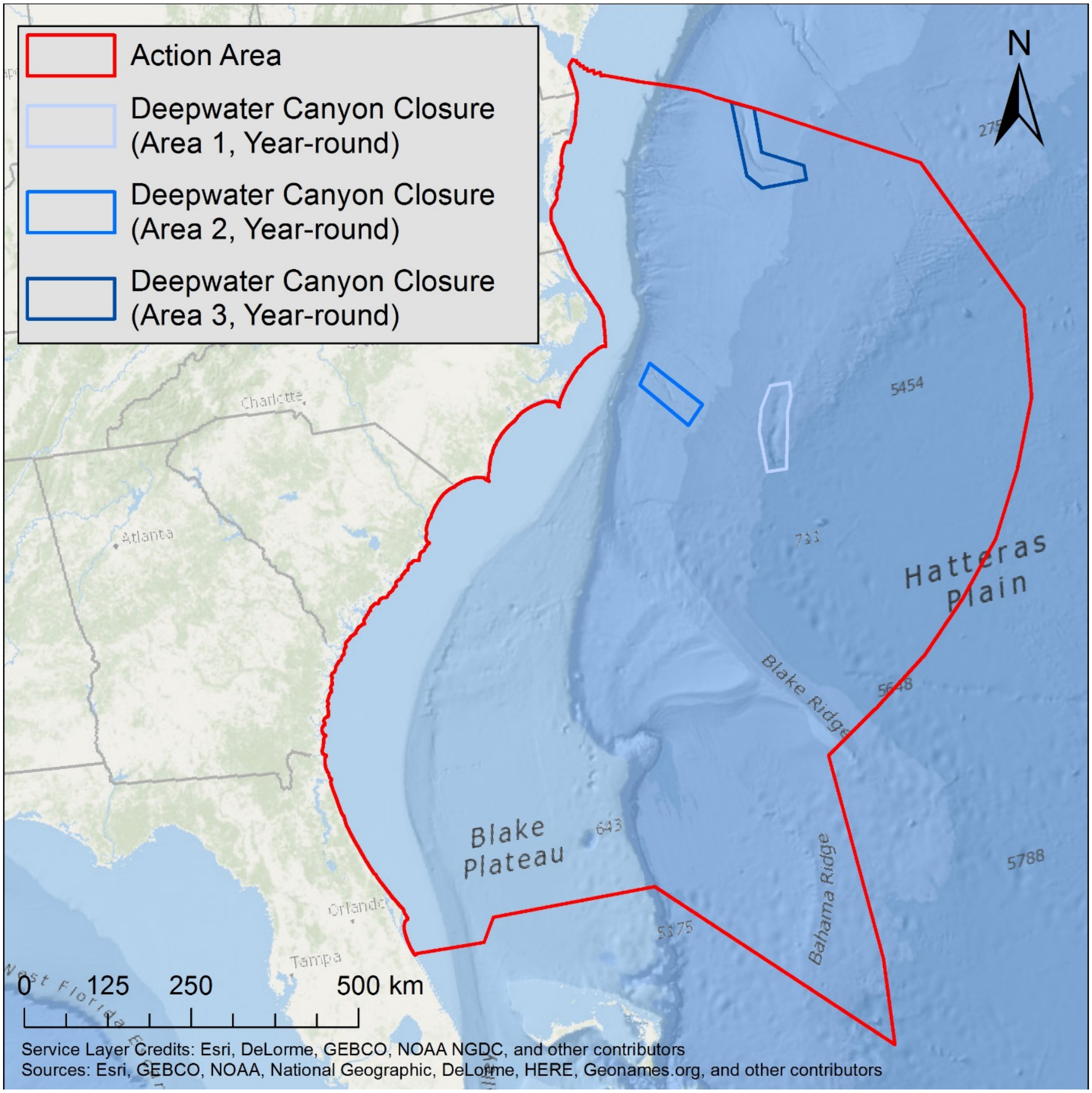

Figure 10. Map of proposed deep-water canyon closures. Seismic surveys would be prohibited within the closures year-round.

Hatteras and North Closure

The shelf break off Cape Hatteras and the area to the north, including slope waters around "The Point" (Area 4, Figure 11) is proposed to be closed to seismic surveys from January through March. Although this closure is expected to be beneficial for a diverse species assemblage of non-ESA-listed species, this area is expected to be particularly beneficial for sperm whales. Based on the proposed tracklines, this condition would be applicable to all to five companies. In the proposed IHAs, this area was originally proposed to be closed from July through September, but was changed during consultation to be closed from January through March based on recent acoustic data suggesting sperm whales are more likely to be found here during these months (Stanistreet et al. 2018).

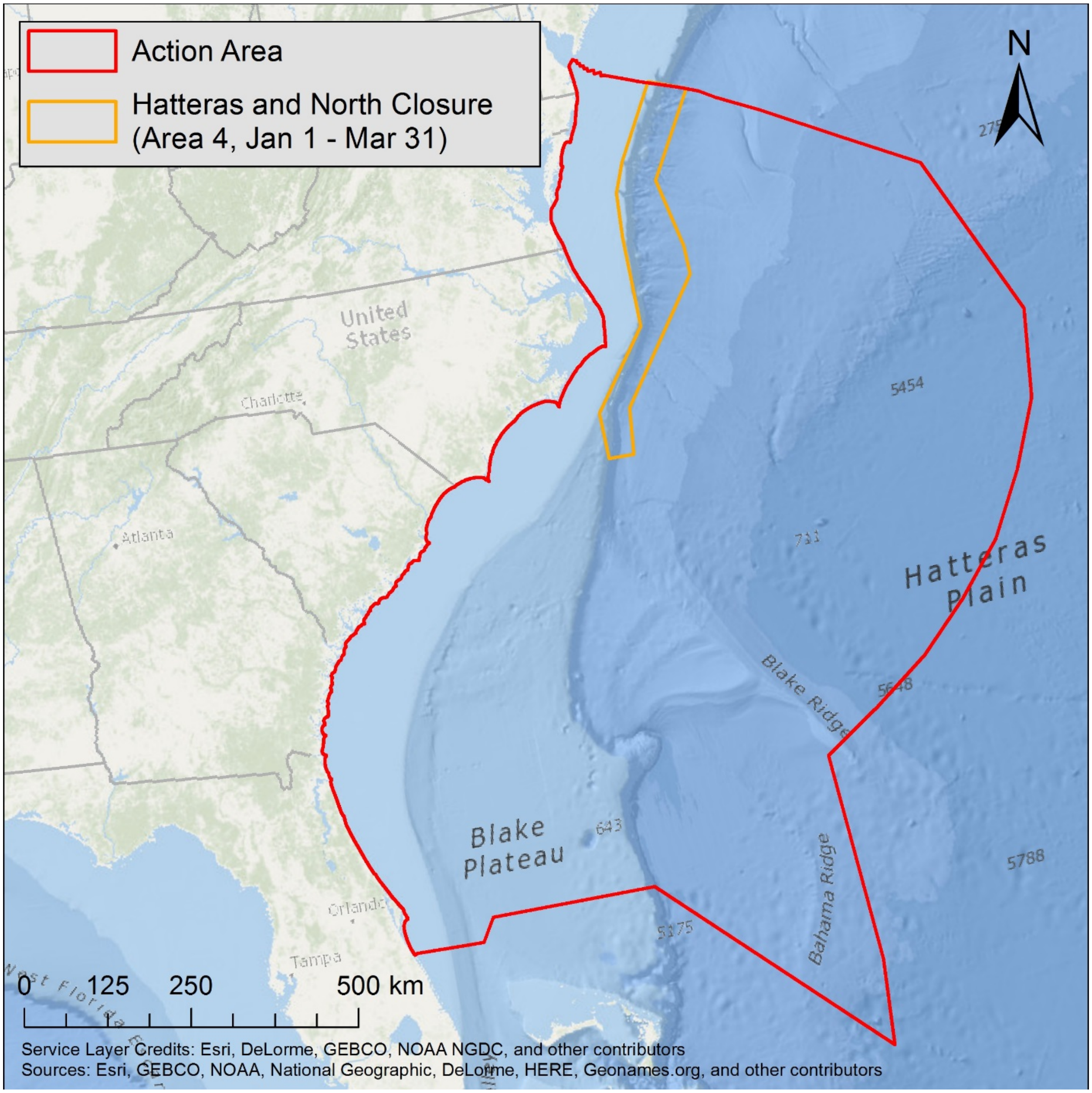

Figure 11. Map of proposed Hatteras and North closure. Seismic surveys would be prohibited within the closure between January 1 and March 31 annually.

3.7.1.4 National Marine Sanctuary Closures

As a result of consultation under the National Marine Sanctuaries Act between BOEM and the National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries, seismic activity will be prohibited within and out to a minimum buffer of 15 km around the boundaries of the Gray's Reef and Monitor National Marine Sanctuaries (Figure 12). Gray's Reef National Marine Sanctuary is located approximately 26 km off the coast of Georgia and is 57 km^2 in area (46 FR 7942). The Monitor National Marine Sanctuary is located approximately 26 km off the North Carolina coast and encompasses the wreck of the USS Monitor (81 FR 879). These restrictions have been incorporated into updated tracklines for several of the companies in updated IHA applications, and BOEM proposed to condition all permits with these restrictions.

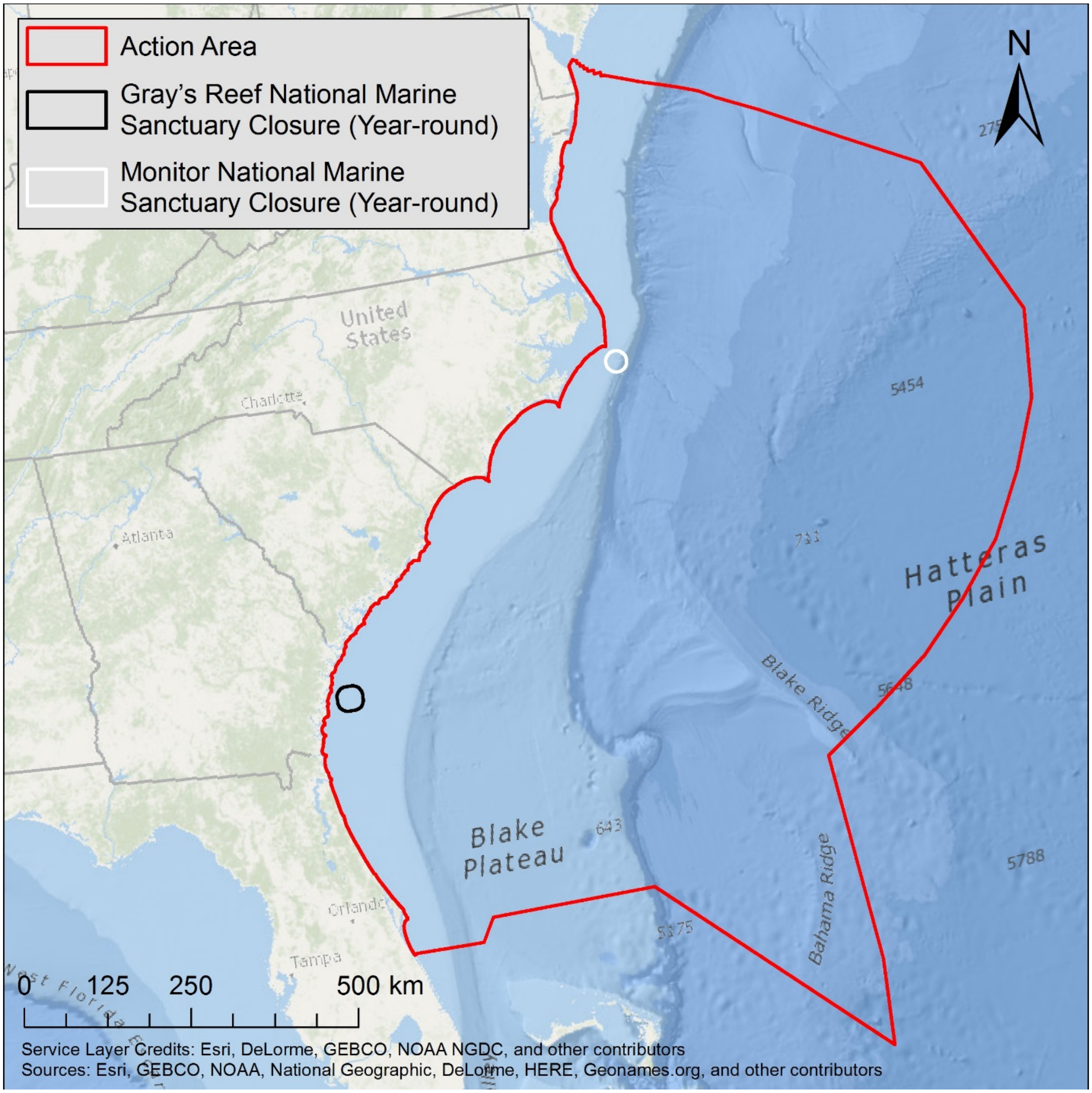

Figure 12. Map of proposed National Marine Sanctuary closures. Seismic surveys would be prohibited within the closures year-round.

3.7.1.5 Coastal Zone Management Act Closures

As a result of coordination with Delaware, Maryland, North Carolina, South Carolina, and Georgia pursuant to the CZMA, the G&G companies agreed to modify their proposed action to meet specific state requirements, which will be incorporated into BOEM's permits. At the time this opinion was prepared, ION, Spectrum, TGS, and CGG had agreed to CZMA restrictions as detailed in Appendix B, but CZMA negotiations were still ongoing with WesternGeco. While the companies agreed to a variety of requirements with the states, here we focus on the time/area closures that are expected to minimize adverse effects to ESA-listed species. All of the CZMA time/area closures were directly incorporated in to proposed seismic survey tracklines (either in the original IHA applications or in revised survey tracklines provided to us by the Permits and Conservation Division) by removing any proposed tracklines in areas closed to seismic activity (either year round or at certain times of the year). As such, the proposed seismic surveys as described above for ION, Spectrum, TGS, and CGG in Sections 3.2, 3.3, 3.4, and 3.6 respectively, already account for these closures. Nevertheless, here we mention one specific seasonal CZMA closure, as it is relevant to our exposure analysis.

- For Spectrum only, no seismic activity would be allowed within 231.5 km of Maryland's coast from April 15 to November 15.

This Maryland closure is not readily apparent in Spectrum's proposed tracklines discussed above because Spectrum still proposes to conduct tracklines within this closure. However, the tracklines within this closures would only be surveyed when the closure is not in effect, unless seismic activity is otherwise prohibited in this areas due other proposed closures (e.g., where the North Atlantic Right Whale Closure overlaps with the Maryland Closure).

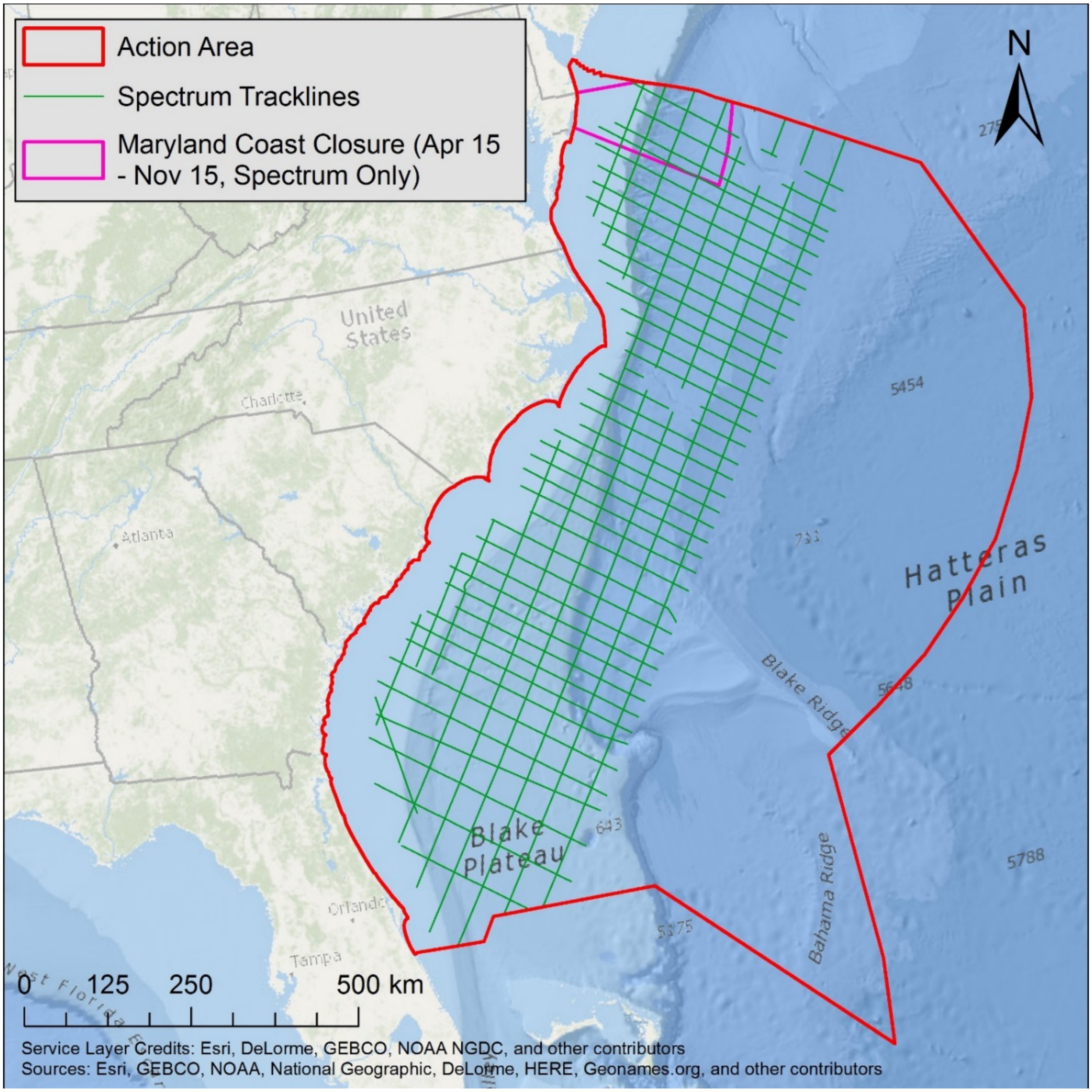

Figure 13. Map of proposed Maryland closure. Spectrum would not conduct seismic surveys within this closure between April 15 and November 15.

3.7.2 Seismic Airgun Survey Protocols

BOEM and the Permits and Conservation Division propose to require specific protocols for all seismic surveys. These protocols include the use of visual and acoustic protected species observers (PSOs), ramp-up procedures, and shutdown requirements. Below we provide an overview of these protocols as they apply to ESA-listed species. Prescriptive details for these protocols, including measure for non-ESA-listed marine mammals, can be found in Appendix C and will be included in the final IHAs. For ESA-listed marine mammals, the protocols in the final IHAs are the same as those proposed by BOEM (Appendix C), but BOEM's proposed protocols also cover non-marine mammal ESA-listed species.

3.7.2.1 Protected Species Observers

Both visual and acoustic PSOs would be required by BOEM and the Permits and Conservation Division as a condition of the permits and IHAs respectively. PSOs are utilized to monitor for protected species (i.e., ESA and MMPA species) and when appropriate, delay start up or initiate shutdown of the airgun arrays to avoid and/or limit the exposure of these species to sound associated with seismic surveys. Visual and acoustic PSOs would be required to regularly communicate and coordinate their efforts to detect protected species. Prior to the seismic surveys being conducted, the Permits and Conservation Division would screen all potential PSOs for their ability to perform their duties.

Visual

The proposed permits and IHAs would require trained visual PSOs to establish and monitor exclusion zones and a buffer zone for marine mammals and sea turtles using hull mounted big eye binoculars. Two exclusion zones would be defined, which depend on the species and context. For North Atlantic right whales, sperm and baleen whales with calves, and aggregations of sperm or baleen whales (i.e., six or more) the exclusion zone would encompass the area at and below the sea surface out to a radius of 1.5 km from the edges of the airgun array (0–1,500 m). Here "calf" is defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult. For all other ESA-listed marine mammals and sea turtles, the exclusion zone would encompass the area at and below the sea surface out to a radius of 500 m from the edges of the airgun array (0–500 m). The buffer zone would be an extension of the exclusion zone and would not be applicable for species and context that require an exclusion zone beyond 500 m. The buffer zone would encompass the area at and below the sea surface from the edge of the 0–500 m exclusion zone, out to a radius of 1000 m from the edges of the airgun array (500–1,000 m). Visual monitoring of the exclusion and buffer zone would begin no less than 30 minutes prior to the beginning of using airguns (including testing) and would continue until airgun operations cease or sighting conditions do not allow observation of the sea surface (e.g., fog, rain, darkness). Further details on visual PSO training, qualifications, and protocols can be found in the draft IHAs (Appendix A), the final IHAs, and Appendix C.

When the airgun array is active, the occurrence of ESA-listed marine mammals within the exclusion zone would require a shutdown of the array (see Section 3.7.2.3 below), while occurrence of such marine mammals within buffer zone but outside the exclusion zone would be communicated to the operator to prepare for a potential shutdown. If a voluntary sea turtle pause is being employed (see Section 3.7.2.3 below), the occurrence of sea turtles within the exclusion zone would initiate a sea turtle pause (see Section 3.7.2.3 below). If a sea turtle pause is not being employed, visual PSOs would still document all observations of sea turtles during the active use of the airgun array, including their relative bearing and distance from the acoustic source as required by the BOEM permits (see Appendix C).

The Permits and Conservation Division proposes a 500-m exclusion zone for most marine mammals because it is expected to contain sound exceeding peak pressure injury criteria for all hearing groups of marine mammals other than high-frequency cetaceans, while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort (82 FR 26244; NOAA 2018). As noted in Section 7.2, the ESA-listed marine mammals considered in this opinion are either low-frequency cetaceans (baleen whales) or mid-frequency cetaceans (sperm whales) and as such, the proposed exclusion zone is appropriate for these species based on peak pressure injury criteria. However, this 500-m exclusion zone would not necessarily encompass the zone expected to cause injury to low frequency cetaceans based on their cumulative sound exposure level thresholds (82 FR 26244; NOAA 2018), and as such may not entirely prevent auditory injury to this hearing group. For sensitive species and/or demographic groups (e.g., North Atlantic right whales, sperm and baleen whales with calves, and aggregations of sperm or baleen whales), the Permits and Conservation Division proposes a larger exclusion zone. In the original proposed IHAs, a shutdown was proposed at any distance, but during consultation the Permits and Conservation Division revised this exclusion zone distance to 2 km and then again to 1.5 km to align with estimates of the effective strip width (a measure of how far animals are seen from the vessel) for North Atlantic right whales (1,309 m) and beaked whales (1,587 m) (Roberts et al. 2016).

For sea turtles, BOEM proposes a 500-m exclusion zone for consistency with the requirements being proposed by the Permits and Conservation Division in the IHAs for marine mammals. However, as noted earlier, shutdowns are not required for sea turtles but a voluntary turtle pause may be employed.

Acoustic

The proposed permits and IHAs would also require acoustic PSOs trained in conducting passive acoustic monitoring (PAM) of marine mammals. Acoustic PSOs would be required to monitor the PAM system beginning at least 30 minutes prior to airgun use (including testing) and continue monitoring at all times during use of airguns. The Permits and Conservation Division would require (and BSEE would typically request) that each company submit a description of the PAM system, the software used, and the monitoring plan for approval prior to conducting seismic surveys. Further details on acoustic PSO and PAM requirements, including acoustic PSO qualifications and training, can be found in the draft IHAs (Appendix A), the final IHAs, and Appendix C.

Similar to with visual PSOs, if an acoustic PSO detects the occurrence of ESA-listed marine mammals within the applicable exclusion zone when the acoustic source is active, a shutdown would be required. The detection of an ESA-listed marine mammal outside the exclusion zone would be communicated to the operator to prepare for a potential shutdown.

If the PAM system malfunctions or becomes damaged, seismic activities would be allowed to continue for 30 minutes without PAM while the acoustic PSO diagnoses the issue. If the PAM system must be repaired, seismic operations would be allowed to continue for up to a maximum of an additional two hours without PAM under daylight hours only if 1) the sea state is less than or equal to Beaufort sea state four, 2) no marine mammals (excluding delphinids) were detected solely by PAM in the exclusion zone in the previous two hours, 3) NMFS and BSEE are notified as soon as practicable with the time and location in which operations began occurring without PAM, and 4) operations with an active acoustic source and no PAM do not exceed a cumulative total of four hours in any 24-hour period.

3.7.2.2 Ramp-Up

As a condition of the permits and IHAs, seismic survey operations would be required to "ramp-up" (also known as "soft start") prior to conducting seismic surveys at full source levels. Ramp-up is conducted to increase the intensity of an airgun array over a period of no less than 20 minutes until maximum source levels are reached. As noted above, visual PSOs would monitor an exclusion and buffer zone for ESA-listed marine mammals and sea turtles, and acoustic PSOs would listen for ESA-listed marine mammals for at least 30 minutes before initiating ramp-up. If no ESA-listed marine mammals or sea turtles are visually detected and no ESA-listed marine mammals are acoustically detected within the applicable zones, ramp-up procedures would commence. Briefly, a single airgun (smallest in terms of volume preferred) would begin firing, followed by stages of doubling the number of active elements such that the total duration of the ramp-up to the full active array takes approximately 20 minutes. Testing of the acoustic source involving all airguns would also require ramp-up, but testing limited to individual source elements or strings would not. In addition, any shutdown regardless of the reason (e.g., detection of marine mammals, mechanical or electronic failure) resulting in the cessation of the sound source for a period greater than 30 minutes would be required to be followed by full ramp-up procedures. Periods of airgun silence not exceeding 30 minutes would not require ramp-up if visual and/or acoustic observations were continued diligently throughout the silent period (requiring daylight and reasonable sighting conditions for visual observations but not for acoustic observations) and no ESA-listed marine mammals or sea turtles were detected in the exclusion zone.

3.7.2.3 Shutdown

Based on PSO (acoustic or visual) detections of an ESA-listed marine mammal, seismic surveys would not be allowed to commence or would be shutdown depending on the animal's distance from the airgun array and the current seismic activities underway. Similarly, visual PSO observations of a sea turtle within the exclusion or buffer zone prior to airgun activation would prevent seismic surveys from commencing, and while not required, sea turtle observations during active seismic surveys may result in a pause depending on the animal's distance from the airgun array.

If an ESA-listed marine mammal or sea turtle is detected (visually or acoustically for marine mammals) within the exclusion or buffer zones during the 30-minute period prior to airgun activation (ramp-up or testing), airgun activation would be delayed until there is a complete consecutive 30-minute period during which no ESA-listed marine mammals or sea turtles are detected within the zones. If an ESA-listed marine mammal is observed within the buffer zone, but outside exclusion zone (i.e., animal observed at 500–1000 m) during active airgun use, visual PSOs would be required to communicate to the operator to prepare for the potential shutdown. If at any time during active use of airguns, an ESA-listed marine mammal is observed within the 500 m exclusion zone, the visual PSO would call for the immediate shutdown of all active airguns. Similarly, if at any time during active use of airguns, an ESA-listed marine mammal is acoustically detected within the exclusion zone, the acoustic PSO would call for the immediate shutdown of all active airguns. Vessel operators would be required to comply immediately with PSO calls for shutdown and any disagreement or discussion would occur only after the shutdown. If at any time an ESA-listed sea turtle is observed within or near the exclusion zone, a shutdown is not required, but BOEM notes that most G&G companies in the Gulf of Mexico employ a “turtle pause”, a voluntary practice during which the visual PSO requests that the operator pause the airgun array for six shots to let the turtle float past the array while it is inactive (BOEM 2017a). According to BOEM (2017a), this six shot pause is not considered to produce a loss of data/production, and as a result, operators would not have to re-survey the area.

Following a shutdown due to the detection of an ESA-listed marine mammal, visual PSOs would continue to monitor the exclusion and buffer zones for ESA-listed marine mammals and sea turtles while acoustic PSOs would continue to listen for marine mammals. If after 30 minutes the originally detected ESA-listed marine mammal appears to no longer be in the exclusion zone or is no longer detected, and no additional ESA-listed marine mammals or sea turtles are detected within the exclusion zone, ramp-up procedures would commence and the seismic survey would be allowed to continue. However, if during the 30-minute period following the shutdown an ESA-listed marine mammal or sea turtle is observed within the exclusion zone, or an ESA-listed marine mammal is acoustically detected within the exclusion zone, ramp-up would be delayed until there is a full 30-minute period with no ESA-listed marine mammal or sea turtle detections as described above.

In addition to these shutdowns and pauses, operators would be required to keep the acoustic source deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Furthermore, firing of the acoustic source at any volume above the stated production volume would be prohibited and the operator would be required to provide information to the PSOs at regular intervals confirming the firing volume.

3.7.3 Vessel Strike Avoidance

As conditions of the IHAs and permits, the Permits and Conservation Division and BOEM propose to include mandatory measures aimed at reducing and avoiding vessel strikes of marine mammals and sea turtles. For marine mammals, the vessel strike avoidance measures proposed by BOEM and the Permits and Conservation Division are the same, but BOEM's vessel strike avoidance measures also address non-marine mammal ESA-listed species. Vessel operators must comply with these measures except under extraordinary circumstances when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. For the purposes of this consultation, we focus on the main components of these vessel strike avoidance measures that would apply to the ESA-listed species considered in this opinion.

Vessel operators and crew would be required to maintain vigilant watch for marine mammals and sea turtles to identify these species at least to broad taxonomic groups, and be required to slow down or stop their vessel or alter course, as appropriate, regardless of vessel size (but see below for exception for vessels towing gear), to avoid striking marine mammals and ESA-listed species. To accomplish this, a visual observer would be required to monitor a vessel strike avoidance zone (based on species, details provided below and in Appendix C) to ensure the potential for strike is minimized. Vessel operators may employ third party visual PSOs to monitor the vessel strike avoidance zone, but this is not required as long as other personnel (e.g., crew) are available and can broadly identify protected species groups as sea turtles, right whales, other whales, or other marine mammals for the purposes of monitoring. Requirements to stop, alter course, or shift into neutral would be waived for vessels towing gear, due to safety concerns. Such vessels travel at slow speeds (approximately 4-5 knots), and thus present a low risk of vessel strike.

The proposed vessel strike avoidance measures depend on species and context. For North Atlantic right whales, all vessels regardless of size would be required to comply with 10-knot speed restrictions in any DMA and SMA when restrictions are active, and in North Atlantic right whale critical habitat within the action area from November 15 to April 15. In addition, all vessels would be required to maintain a separation distance of 500 m or greater from North Atlantic right whales. For sperm whales and all other baleen whales, vessels would be required to maintain a distance of 100 m. For all other ESA-listed species (e.g., sea turtles), vessels would be required to maintain a minimum distance of 50 m, with an exception made for those animals that approach the vessel. Regardless of species, all vessels would be required to reduce speeds to 10 knots or less when mother/calf pairs, pods, or assemblages of marine mammals are observed near a vessel. When marine mammals or ESA-listed species are sighted while a vessel is underway, the vessel should take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If a marine mammal or ESA-listed species is sighted within the relevant separation distance, the vessel should reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area.

3.7.4 Marine Debris Awareness

Along with the permits, BOEM proposes to include guidance on the handling and disposal of marine trash and debris, similar to BSEE's Notice to Lessees (NTL) 2015-G03[13] (Appendix E) and as described in the conditions of the permits. This guidance is designed to inform seismic operators of the various regulations in place prohibiting marine trash and debris pollution and also requires them to 1) post placards containing relevant information on marine trash and debris regulations as specified in Appendix 1 of BSEE NTL 2015-G03 and notify crew of these placards during vessel orientation, and 2) require crew to complete marine trash and debris awareness training annually and certify that crew do in fact complete this training. More details can be found in the BSEE NTL 2015-G03 (Appendix E).

4 INTERRELATED AND INTERDEPENDENT ACTIONS

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent utility apart from the action under consideration. For this consultation, we consider all vessel and aircraft transit associated with the seismic activities that would be conducted under each IHA/BOEM permit as interdependent. Thus, we evaluate the effects of these activities on ESA-listed species and include all waters traversed during such transits as part of the action area. No actions were considered interrelated.

5 STRESSORS CREATED BY THE PROPOSED ACTION

The proposed action involves multiple activities, each of which can create stressors. Stressors are any physical, chemical, or biological entity that may directly or indirectly induce an adverse response either in an ESA-listed species or their designated critical habitat. During consultation, we deconstructed the proposed action to identify stressors that are reasonably certain to result from the proposed activities. These can be categorized as pollution (e.g., fuel, oil, trash), vessel strikes, acoustic and visual disturbance (aircraft, vessels, echosounders, and seismic airguns), and entanglement in towed seismic equipment. Below we provide a brief introduction to these stressors and their potential effects to ESA-listed species and designated critical habitat. Detailed information on the effects of these potential stressors can be found in our effects analysis in Section 9. Notably, the proposed action includes several conservation measures described in Section 3.7 that are designed to minimize effects that may result from these potential stressors. While we consider all of these measures important and expect them to be effective in minimizing the effects of potential stressors, they do not completely eliminate the identified stressors. Nevertheless, we treat them as part of the proposed action and fully consider them when evaluating the effects of the proposed action (Section 9).

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[13] https://www.bsee.gov/sites/bsee.gov/files/notices-to-lessees-ntl/alerts/ntl-2015-g03.pdf

5.1 Pollution

The operation of vessels and aircraft associated with the proposed action may result in pollution from exhaust, fuel, oil, trash, and other debris. Air and water quality are the basis of a healthy environment for all species. Emissions pollute the air, which could be harmful to air-breathing organisms and lead to ocean pollution (Chance et al. 2015; Duce et al. 1991). Emissions also cause increased greenhouse gases (carbon dioxide, methane, nitrous oxide, and other fluorinated gases) that can deplete the ozone, affect natural earth cycles, and ultimately contribute to climate change (see https://www.epa.gov/ghgemissions/overview-greenhouse-gases for additional information). The release of marine debris such as paper, plastic, wood, glass, and metal associated with vessel operations can also have adverse effects on marine species most commonly through entanglement or ingestion (Gall and Thompson 2015).While lethal and non-lethal effects to air breathing marine animals such sea turtles, birds, and marine mammals are well documented, marine debris also adversely affects marine fish (Gall and Thompson 2015).

As noted in Section 3.7.4, BOEM proposes to include guidance on the handling and disposal of marine trash and debris in its permits, similar to BSEE NTL 2015-G03 (Appendix E). While this is expected to reduce the amount of pollution that may result from the proposed action, pollution remains a potential stressor.

5.2 Vessel Strikes

Seismic surveys necessarily involve vessel traffic within the marine environment, and the transit of any vessel in waters inhabited by ESA-listed species carries the risk of a vessel strike. Vessel strikes are known to adversely affect ESA-listed sea turtles, fishes, and marine mammals (Brown and Murphy 2010; Laist et al. 2001; NMFS and USFWS 2008; Work et al. 2010). The probability of a vessel collision depends on the number, size, and speed of vessels, as well as the distribution, abundance, and behavior of the species (Conn and Silber 2013; Hazel et al. 2007; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). If an animal is struck by a vessel, it may experience minor, non-lethal injuries, serious injuries, or death.

Several conservation measures proposed by the Permits and Conservation Division and/or BOEM would minimize the risk of vessel strike (see Section 3.7.3 above). In addition, the overall level of vessel activity associated with the proposed action is low relative to the large size of the action area, further reducing the likelihood of a vessel strike of an ESA-listed species. Nevertheless, vessel strikes remain a potential stressor associated with the proposed action.

5.3 Acoustic and Visual Disturbance

The proposed action would produce a variety of different sounds including those associated with vessel and aircraft operations, echosounders, and airguns that may produce an acoustic disturbance or otherwise affect ESA-listed species. It would also involve the presence of vessels (and associated gear) and aircraft that produce a visual disturbance that may affect ESA-listed marine mammals and sea turtles.

Vessels and aircraft associated with the proposed action may cause visual or auditory disturbances to ESA-listed that spend time near the surface, such as sea turtles and cetaceans, and more generally disrupt their behavior. Studies have shown that vessel operation can result in changes in the behavior of cetaceans and sea turtles (Arcangeli and Crosti 2009; Hazel et al. 2007; Holt et al. 2009; Luksenburg and Parsons 2009; Noren et al. 2009; Patenaude et al. 2002; Richter et al. 2003; Richter et al. 2006; Smultea et al. 2008). In addition, cetaceans and sea turtles may exhibit a behavioral response to aircraft operations (Luksenburg and Parsons 2009; NMFS 2017b; NMFS 2017c; NMFS 2017d; NMFS 2017g; Patenaude et al. 2002; Smultea et al. 2008; Würsig et al. 1998). In many cases, particularly when responses are observed at great distances, it is thought that animals are likely responding to sound more than the visual presence of vessels and/or aircraft (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). Nonetheless, it is generally not possible to distinguish responses to the visual presences of aircraft and/or vessels from those to the sounds associated with aircraft and/or vessels. Moreover, at close distances animals may not even differentiate between visual and acoustic disturbances created by vessels and aircraft and simply respond to the combined disturbance.

Unlike vessels and aircraft, which produce sound as a byproduct of their operations, echosounders and seismic airguns are designed to actively produce sound, and as such, the characteristics of these sound sources are deliberate and under control. Assessing whether these sounds may adversely affect ESA-listed species involves understanding the characteristics of the acoustic sources, the species that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those species. Although it is known that sound is important for marine mammal communication, navigation, and foraging (NRC 2003; NRC 2005), there are many unknowns in assessing impacts of sound, such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007). Other ESA-listed species such as such as sea turtles are often considered less sensitive to anthropogenic sound, but given that much less is known about how they use sound, the impacts of anthropogenic sound are difficult to assess (Nelms et al. 2016; Popper et al. 2014). Nonetheless, depending on the circumstances exposure to anthropogenic sounds may result in auditory injury, changes in hearing ability, masking of important sounds, behavioral responses, as well as other physical and physiological responses (see Section 9).

Several of the conservation measures associated with the proposed action such as time/area closures and seismic airgun survey protocols are specifically designed to minimize effects that may result from the stressor of seismic airgun sounds. In addition, while not specifically designed to do so, several aspects of the proposed vessel strike avoidance measures would minimize effects associated with vessel disturbance. However, even with these measures, visual and acoustic disturbances are considered a potential stressor.

5.4 Entanglement

The towed seismic equipment associated with the proposed seismic surveys may pose a risk of entanglement to ESA-listed species. Entanglement can result in death or injury of marine mammals and sea turtles (Duncan et al. 2017; Moore et al. 2009; van Der Hoop et al. 2013). Marine mammal and sea turtle entanglement, or by-catch, is a global problem that every year results in the death of hundreds of thousands of animals worldwide. Entangled marine mammals and sea turtles may drown or starve due to being restricted by gear, suffer physical trauma and systemic infections, and/or be hit by vessels due to an inability to avoid them. For smaller animals like sea turtles, death is usually quick, and due to drowning. However, large whales, like North Atlantic right whales, can typically pull gear, or parts of it, off the ocean floor, and are generally not in immediate risk of drowning. Nonetheless, depending on the entanglement, towing gear for long periods may prevent a whale from being able to feed, migrate, or reproduce (Lysiak et al. 2018; van der Hoop et al. 2017).

6 ACTION AREA

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02). The action area for this consultation includes waters under BOEM's jurisdiction within BOEM's Mid- and South Atlantic planning areas. This includes waters between three nautical miles (the limit for state waters) and 200 nautical miles (the limit of the U.S. EEZ) from Delaware to approximately Cape Canaveral, Florida. The action area also includes additional waters on the extended continental shelf (350 nautical miles from shore) where seismic surveys will occur outside the U.S. EEZ and BOEM's jurisdiction, but are proposed for authorization by the Permits and Conservation Division. A map of a minimum bounding polygon encompassing the proposed seismic survey track lines can be seen in Figure 14. Note that the action area includes waters outside this polygon that would either be transited by aircraft or vessels associated with the proposed action or be ensonified to levels that would be expected to impact ESA-listed species (see Section 9 for more details on the ensonified areas for each company). Within the action area, the proposed seismic surveys would take place over the period of a year: for ION between July and December, for Spectrum between February and July, and for TGS, WesternGeco, and CGG, anytime of the year.

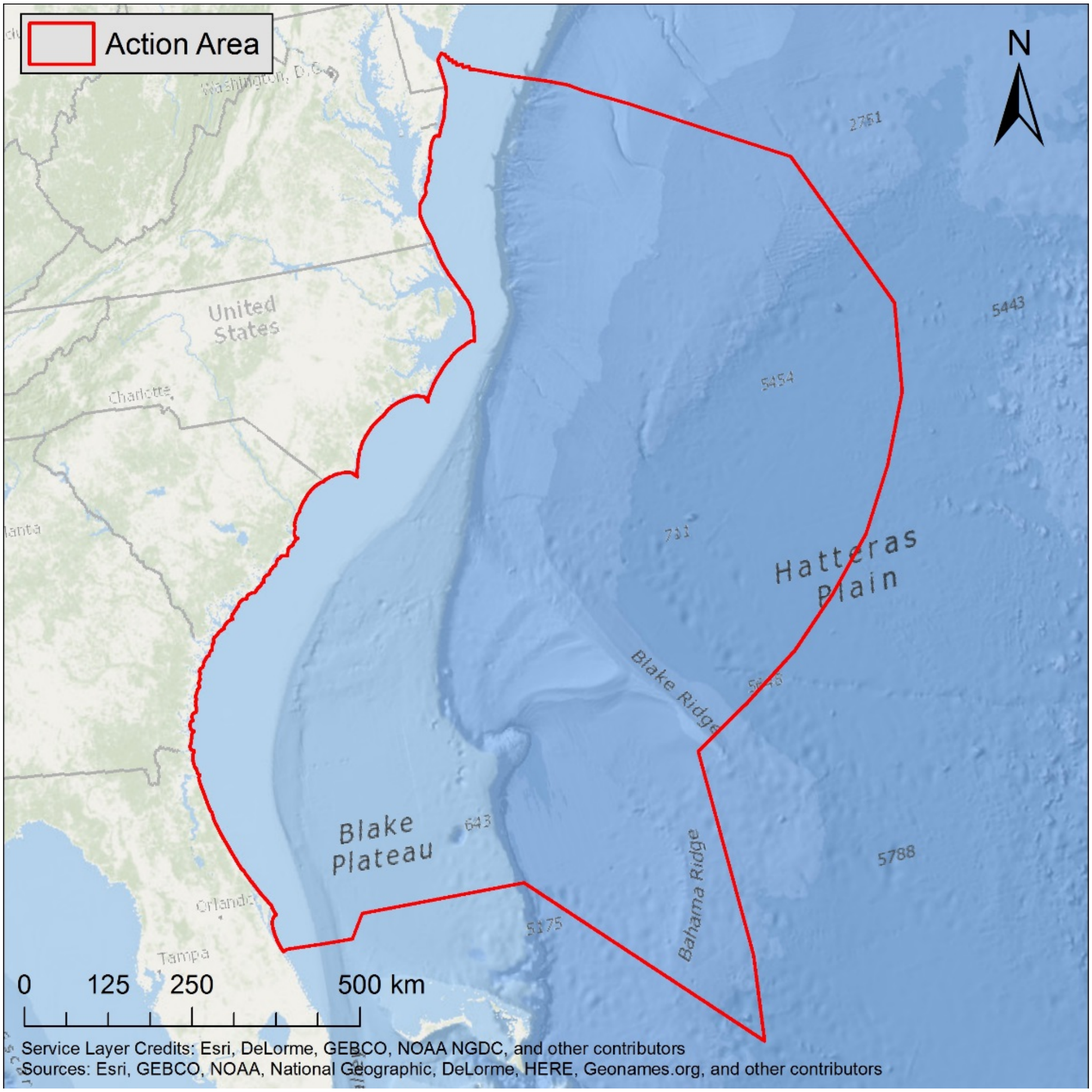

Figure 14. Map of the action area. Red area represents a minimum bounding polygon surrounding the proposed seismic survey tracklines.

7 Species and Designated Critical Habitat that may be Affected

This section identifies the ESA-listed species and designated critical habitat that potentially occur within the action area that may be affected by the proposed action. It then identifies those species not likely to be adversely affected by the proposed action because the effects of the proposed action are deemed insignificant, discountable, or fully beneficial. Finally, this section summarizes the biology and ecology of those species that may be adversely affected by the proposed action and details information on their life histories in the action area, if known. The

ESA-listed species and designated critical habitat potentially occurring within the action area that may be affected by the proposed action are given in Table 3 and Table 4, along with their regulatory status.

Table 3: Endangered Species Act-listed species that may be affected by the proposed action.

Species	ESA Status	Recovery Plan
Marine Mammals – Cetaceans		
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	07/1998
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	75 FR 47538
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	70 FR 32293
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	12/2011
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	75 FR 81584
Marine Reptiles		
Green Sea Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	U.S. Atlantic 1991
Hawksbill Sea Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 28359 and 57 FR 38818
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	9/2011
Leatherback Sea Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	63 FR 28359 and 10/1991
Loggerhead Sea Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	74 FR 2995
Fishes		
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Carolina DPS	E – 77 FR 5913	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Chesapeake Bay DPS	E – 77 FR 5879	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – Gulf of Maine DPS	E – 77 FR 5879	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – New York Bight DPS	E – 77 FR 5879	-- --
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) – South Atlantic DPS	E – 77 FR 5913	-- --
Giant Manta Ray (*Manta birostris*)	T -- 83 FR 2916	-- --
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --

Table 4. Endangered Species Act designated critical habitat that occurs within or near the action area.

Designated Critical Habitat	Federal Register Notice	Units
Loggerhead Sea Turtle – Northwest Atlantic Ocean DPS Critical Habitat	79 FR 39856	LOGG-N-01 to LOGG-N-17, LOGG-S-01
Atlantic Sturgeon (Carolina, Chesapeake Bay, New York Bight, and South Atlantic DPSs) Critical Habitat	82 FR 39160	New York Bight Unit 4, Chesapeake Bay Units 1-5, Carolina Units 1-7, South Atlantic Units 1-7
North Atlantic Right Whale Critical Habitat	81 FR 4837	Unit 2

7.1 Species and Designated Critical Habitat Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed or critical habitat that are not likely to be adversely affected by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is not likely to be adversely affected by those activities.

The second criterion is the probability of a response given exposure. An ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also not likely to be adversely affected by the proposed action. We applied these criteria to the ESA-listed species in Table 3 and Table 4 and we summarize our results below.

An action warrants a "may affect, not likely to be adversely affected" finding when its effects are wholly *beneficial, insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

7.1.1 Atlantic Sturgeon

Sub-adult and adult Atlantic sturgeon from all five distinct population segments occur in the marine environment and may be exposed to the proposed action. There are gaps in our understanding about the offshore marine distribution of Atlantic sturgeon. Much of the available data point to Atlantic sturgeon using relatively nearshore, shallow habitats, but there are reports of Atlantic sturgeon being captured in waters 75 m deep.

The proposed action will take place in waters 50 to 6,000 m deep. A seasonal closure area for the North Atlantic right whale will not allow seismic activities to take place within 90 km off the coast from November 1 to April 30. There will also be a year-round 30-km coastal closure within the action area.

Bycatch data offer insight into the marine distribution of Atlantic sturgeon. During observed fishing trips using trawls, the majority of Atlantic sturgeon captures occurred in waters 20 m deep or less (ASMFC 2017). Studies focusing on Atlantic sturgeon in the New York Bight have found that Atlantic sturgeon appear to prefer waters 20 m or less (Dunton et al. 2010), with no captures occurring in waters greater than 20 m (Dunton et al. 2015). Other observations have found Atlantic sturgeon in deeper waters (up to 50 m) (ASMFC 2017; Stein et al. 2004), and even as deep as 75 m (Colette and Klein-MacPhee 2002). In South Carolina, tagged Atlantic sturgeon were detected up to 24 km from shore[14], placing them in waters between 10 and 20 m deep.

There is also evidence that Atlantic sturgeon marine habitat use changes with season. Erickson et al. (2011) found that Atlantic sturgeon occupied deeper waters in the fall and winter (October through March) than in the spring and summer. From April to June, sturgeon occupied a mean water depth of 12.9 m (3.8 to 37.7 m), and 9.9 m (4.5 to 25.0 m) in July through September. In fall (October through December) and winter (January through March), Atlantic sturgeon occupied deeper waters, averaging 16.1 m (2.0 to 33.9 m) and 24.4 m (6.5 to 37.6 m), respectively (Erickson et al. 2011). In addition, aggregations of Atlantic sturgeon have been detected by telemetry arrays off the coast of Virginia, with groups of 40 or more individuals found at stations 53 km from shore (20 to 30 m deep) in January through April (Watterson 2017; Watterson personal communication to C. Cairns on December 5, 2017). Groups of six to 20 sturgeon were found as far as 83 km from shore (30 to 40 m deep) during that same period. In summer, there were no sturgeon detections that far out; the few sturgeon that were detected were closer to shore (28 km or less, in waters less than 20 m deep). Similarly, reports of Atlantic sturgeon habitat use in and near BOEM's Maryland Wind Energy Area off the coast of Maryland indicate individuals prefer inshore, shallow waters during warmer months, with an increase in detections in deeper waters, further offshore during winter months (Secor and Bailey 2017). It is possible that the movement of adult Atlantic sturgeon in the marine environment is driven by physical conditions; other life-stages of Atlantic sturgeon also make seasonal movements in rivers and estuaries, likely driven by water temperature or prey availability (ASMFC 2017).

The proposed 90 km North Atlantic right whale closure covers a range of depths where Atlantic sturgeon have frequently been recorded in the marine environment (10 to 50 m) (Figure 15).

[14] See http://dnr.sc.gov/marine/receiverstudy/sturgeon.html

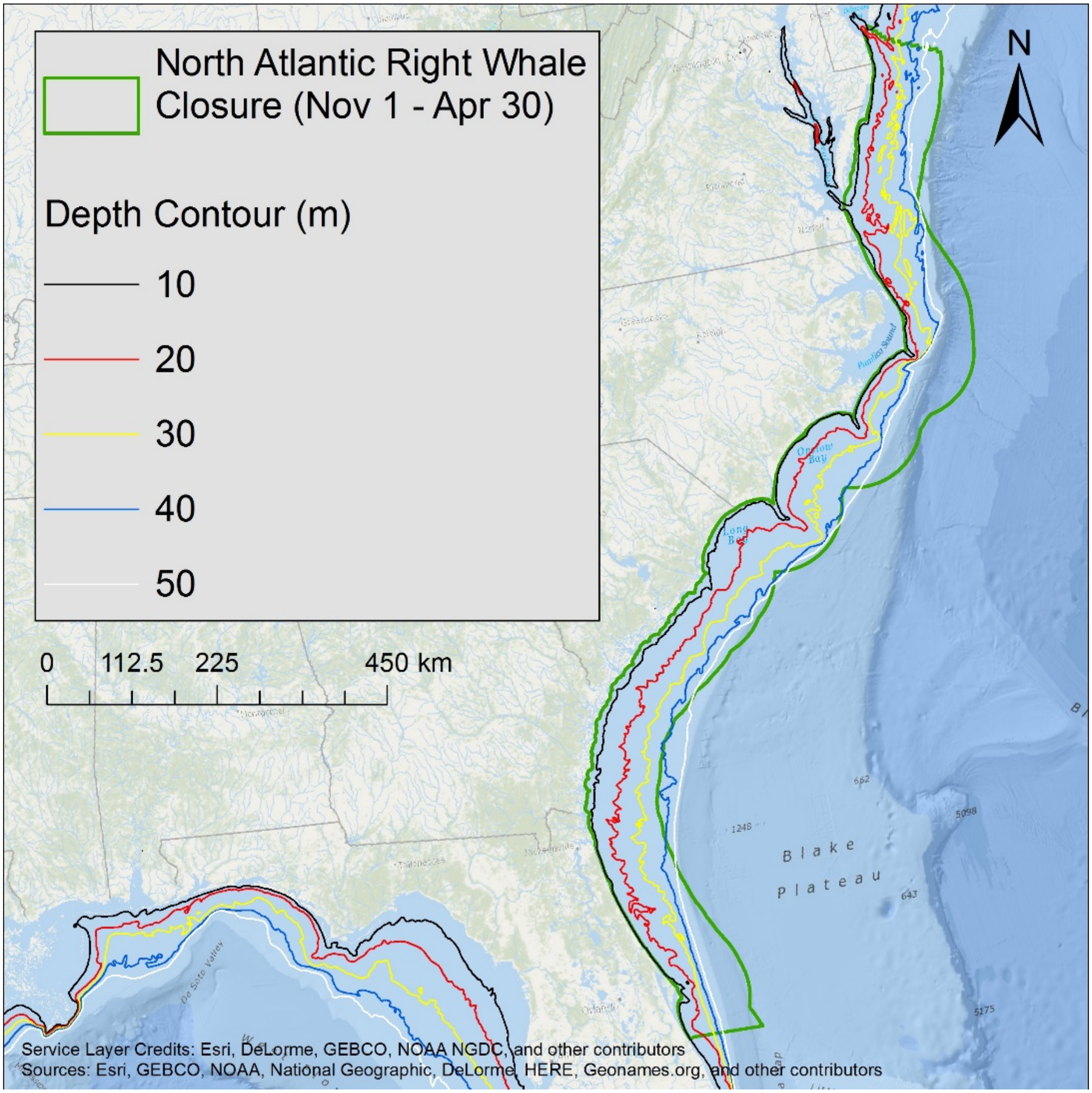

Figure 15. Proposed seasonal North Atlantic right whale closure with 10 to 50 meter depth contours.

Based on Erickson et al. (2011) and the information from the coastal Virginia array, Atlantic sturgeon occupied deeper waters in the fall and winter, moving inshore to shallower waters in April through September. The 90-km North Atlantic right whale seasonal closure area would be in effect from November 1 to April 30, during the time when we expect Atlantic sturgeon to be present in relatively deeper waters further from shore. As such, the 90-km North Atlantic right whale seasonal closure area would largely prevent Atlantic sturgeon from being exposed to the proposed action from November to April. During other times of the year when this closure would not be in effect, the 30-km coastal closure would be in effect. While not as large as the 90-km

North Atlantic right whale seasonal closure, the 30-km coastal closure would cover most of the shallower, inshore areas where we expect Atlantic sturgeon to be in the spring and summer (Erickson et al. 2011) (Figure 16). We believe that these two closure areas will largely prevent Atlantic sturgeon exposure to the proposed seismic activities.

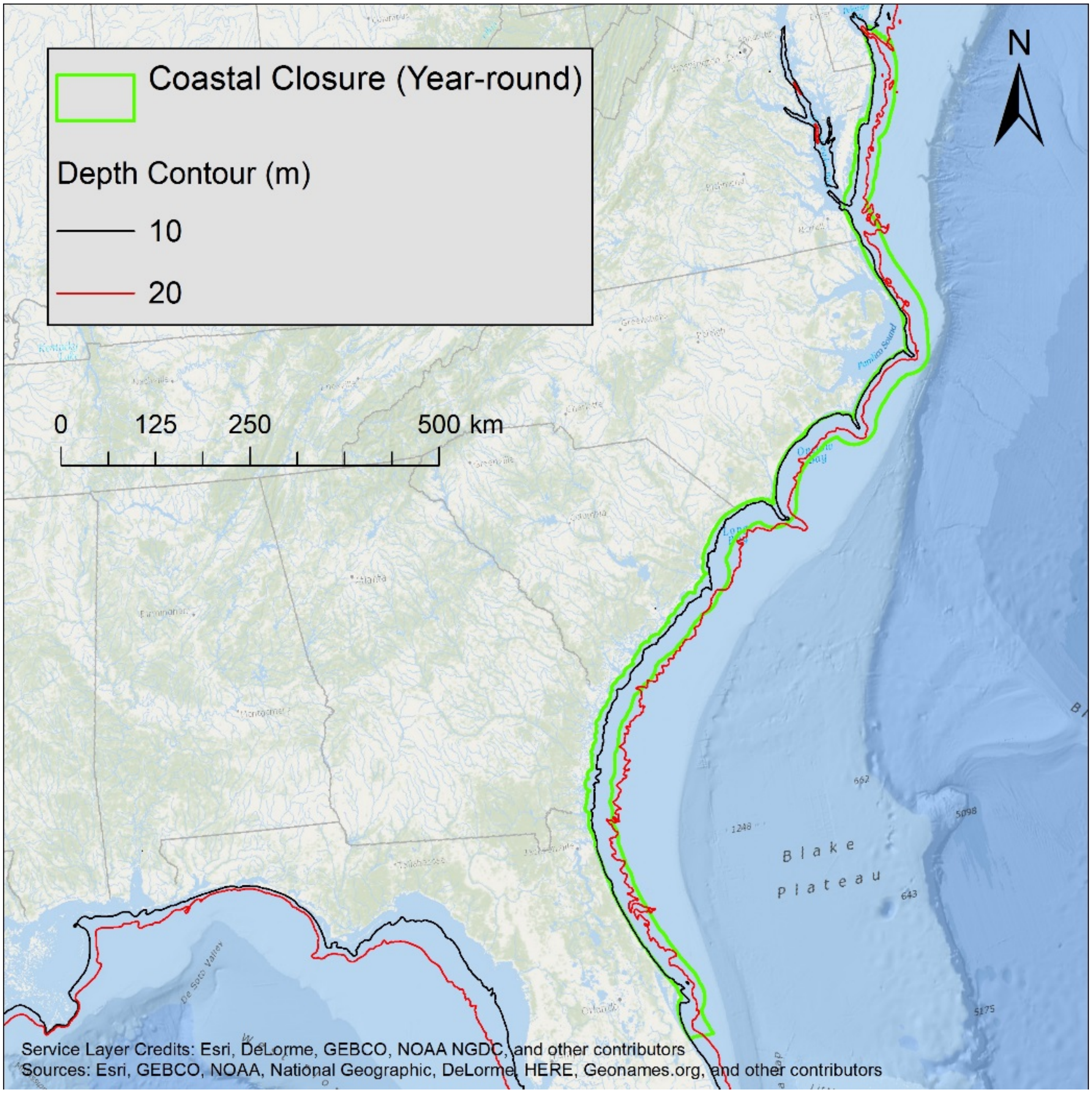

Figure 16. Proposed year-round coastal closure with 10 and 20 meter depth contours.

Based on what we understand about Atlantic sturgeon marine distribution, it seems likely that they will mostly be prevented from exposure due to the closure areas. However, it is possible that some Atlantic sturgeon could be exposed to the proposed action, as the closure areas do not completely cover all of the depth areas where we expect Atlantic sturgeon to be during the entire year. In the event that an Atlantic sturgeon is exposed to seismic activities, we provide a discussion on sturgeon hearing and a description of the sound sources in the proposed action below to consider the potential effects to Atlantic sturgeon.

The seismic airguns proposed for use produce impulsive sounds. Airguns produce sound with energy in a frequency range from about 10 to 2,000 Hz, with most energy radiated at frequencies below 200 Hz. In additional to impulsive airgun sounds, the proposed action would produce non-impulsive sounds from vessels and echosounders. Sounds emitted by survey vessels would be low frequency and continuous, but would be widely dispersed in both space and time. In contrast, echosounders generally produce higher frequency, intermittent sounds used to estimate bathymetry, and would be more localized to the vessels from which they are used. The five companies would use different echosounders during their surveys, but all would operate at a high frequency, from 18 kHz to 200 kHz.

There is no available information on the hearing capabilities of Atlantic sturgeon specifically, although the hearing of two species of sturgeon have been studied. While sturgeon have swimbladders, they are not known to be used for hearing, and thus sturgeon appear to only rely directly on their ears for hearing. Popper (2005) reported that studies measuring responses of the ear of European sturgeon (*Acipenser sturio*) using physiological methods suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz, indicating that sturgeon should be able to localize or determine the direction of origin of sound. Meyer and Popper (2002) recorded auditory evoked potentials of varying frequencies and intensities for lake sturgeon (*Acipenser fulvescens*) and found that lake sturgeon can detect pure tones from 100 Hz to 2 kHz, with best hearing sensitivity from 100 to 400 Hz. They also compared these sturgeon data with comparable data for oscar (*Astronotus ocellatus*) and goldfish (*Carassius auratus*) and reported that the auditory brainstem responses for the lake sturgeon were more similar to goldfish (which is considered a hearing specialist that can hear up to 5 kHz) than to the oscar (which is a non-specialist that can only detect sound up to 400 Hz); these authors, however, felt additional data were necessary before lake sturgeon could be considered specialized for hearing (Meyer and Popper 2002). Lovell et al. (2005) also studied sound reception and the hearing abilities of paddlefish (*Polyodon spathula*) and lake sturgeon. Using a combination of morphological and physiological techniques, they determined that paddlefish and lake sturgeon were responsive to sounds ranging in frequency from 100 to 500 Hz, with the lowest hearing thresholds from frequencies in a bandwidth of between 200 and 300 Hz and higher thresholds at 100 and 500 Hz; lake sturgeon were not sensitive to sound pressure. We assume that the hearing sensitivities reported for these other species of sturgeon are representative of the hearing sensitivities of all Atlantic sturgeon DPSs.

Sturgeon are known to produce sounds, especially during spawning. Lake sturgeon produce low frequency sounds during spawning bouts, principally consisting of drumming sounds that range from 5 to 8 Hz, but low frequency rumbles and hydrodynamic sounds as well as high frequency sounds have also been reported (Bocast et al. 2014). The pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*Scaphirhynchus platorynchus*) are known to produce at least four types of sounds during the breeding season, ranging from squeaks and chirps from 1 to 2 kHz, with low frequency moans ranging in frequency between 90 and 400 Hz (Johnston and Phillips 2003).

Based on the above review, it is likely that the proposed seismic activities would be audible to ESA-listed sturgeon found within the action area, and as such, may elicit a behavioral response. However, Popper et al. (2014) concluded that the relative risk of a fish eliciting a behavioral response to low-frequency sonar was low, regardless of the distance from the sound source. The authors did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking would only occur in a narrow range of frequencies being masked by the sonar transmissions (Popper et al. 2014).

The precise expected response of ESA-listed sturgeon to low-frequency acoustic energy is not completely understood due to a lack of sufficient experimental and observational data for this taxon. Given the signal type and level of exposure to the low frequency sounds produced during the seismic operations (from the airguns or the echosounders), and the fact that most sturgeon are found in a nearshore coastal areas, we do not expect frequent exposure or significant responses from any exposures (including significant behavioral adjustments, temporary threshold shirts [TTS] or permanent threshold shifts [PTS], injury, or mortality). The most likely response of ESA-listed sturgeon exposed to the airguns and echosounders, if any, would be minor temporary changes in behavior including increased swimming rate, avoidance of the sound source, or changes in orientation to the sound source, none of which rise to the level of take. If these behavioral reactions were to occur, we do not expect that they would have fitness impacts for the individual, the population, or the DPS. Therefore, the potential effect of the proposed seismic surveys on Atlantic sturgeon is considered insignificant.

Vessels associated with the proposed action would transit waters that may be occupied by Atlantic sturgeon when in route to the proposed seismic survey tracklines. As such, there is a possibility that a vessel associated with the propose action may strike an individual Atlantic sturgeon. However, we find the likelihood of such an event to be extremely low, and thus discountable. This is because relatively few vessels would be used (16 total vessels across all five G&G companies), all of which would be traveling at relatively slow speeds, and because sturgeon tend to occupy the lower parts of the water column where vessel strikes would not occur. Similarly, the stressors of pollution, visual disturbance, and entanglement associated with the proposed action are considered insignificant stressors to Atlantic sturgeon since these stressors mostly reside at the water's surface, and would not reach waters inhabited by Atlantic sturgeon at meaningful levels.

In summary, we conclude that the proposed action is not likely to adversely affect any distinct population segment of ESA-listed Atlantic sturgeon because any effects would be insignificant. As a result, Atlantic sturgeon are not considered further in this opinion.

7.1.2 Elasmobranchs (Giant Manta Ray and Oceanic Whitetip Shark)

ESA-listed elasmobranchs (giant manta rays and oceanic whitetip sharks) may occur in the action area and be affected by sound fields generated by airguns and echosounders. The stressors of pollution, vessel strike, visual disturbance, and entanglement associated with the proposed action are considered insignificant stressors to ESA-listed elasmobranchs since these stressors mostly reside at the water's surface, and would not reach waters inhabited by ESA-listed elasmobranchs at meaningful levels.

Elasmobranchs, like all fish, have an inner ear capable of detecting sound and a lateral line capable of detecting water motion caused by sound (Hastings and Popper 2005; Popper and Schilt 2009). Data for elasmobranch fishes suggest they are capable of detecting sounds from approximately 20 Hz to 1 kHz with the highest sensitivity to sounds at lower ranges (Casper et al. 2012; Casper et al. 2003; Casper and Mann 2006; Casper and Mann 2009; Ladich and Fay 2013; Myrberg 2001). However, unlike most teleost fish, elasmobranchs do not have swim bladders (or any other air-filled cavity), and thus are unable to detect sound pressure (Casper et al. 2012). Particle motion is presumably the only sound stimulus that can be detected by elasmobranchs (Casper et al. 2012). Given their assumed hearing range, elasmobranchs are anticipated to be able to detect the low frequency sound from an airgun array if exposed. However, the duration and intensity of low-frequency acoustic stressors and the implementation of conservation measures (described in Section 3.7) will likely minimize the effect this stressor has on elasmobranchs. Furthermore, although some elasmobranchs have been known to respond to anthropogenic sound, in general elasmobranchs are not considered particularly sensitive to sound (Casper et al. 2012).

There have been no studies examining the direct effects of exposure to specific anthropogenic sound sources in any species of elasmobranchs (Casper et al. 2012). However, several elasmobranch species, including the oceanic silky shark (*Carcharhinus falciformis*) and coastal lemon shark (*Negaprion brevirostris*), have been observed withdrawing from pulsed low-frequency sounds played from an underwater speaker (Klimley and Myrberg 1979; Myrberg et al. 1978). Lemon sharks exhibited withdrawal responses to pulsed low to mid-frequency sounds (500 Hz to 4 kHz) raised 18 dB re: 1 μPa at an onset rate of 96 dB re: 1 μPa per second to a peak amplitude of 123 dB re: 1 μPa received level from a continuous level, just masking broadband ambient sound (Klimley and Myrberg 1979). In the same study, lemon sharks withdrew from artificial sounds that included 10 pulses per second and 15 to 7.5 decreasing pulses per second.

In contrast, other elasmobranch species are attracted to pulsing low frequency sounds. Myrberg (2001) stated that sharks have demonstrated highest sensitivity to low frequency sound (40 to 800 Hz). Free-ranging sharks are attracted to sounds possessing specific characteristics including irregular pulsed, broadband frequencies below 80 Hz and transmitted suddenly without an increase in intensity, thus resembling struggling fish.

These signals, some "pulsed," are not substantially different from the airgun array signals. Myrberg et al. (1978) reported that silky shark withdrew 10 m from a speaker broadcasting a 150 to 600 Hz sound with a sudden onset and peak source level of 154 dB re: 1 µPa. These sharks avoided a pulsed low frequency attractive sound when its sound level was abruptly increased by more than 20 dB re: 1 µPa. Other factors enhancing withdrawal were sudden changes in the spectral or temporal qualities of the transmitted sound. The pelagic oceanic whitetip shark also showed a withdrawal response during limited tests, but less so than other species (Myrberg et al. 1978). These results do not rule out that such sounds may have been harmful to the fish after habituation; the tests were not designed to examine that point.

Popper et al. (2014) concluded that the relative risk of fishes with no swim bladders exhibiting a behavioral response to low-frequency active sonar was low, regardless of the distance from the sound source. The authors did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking will result in a narrow range of frequencies being masked (Popper et al. 2014). Popper et al. (2014) also concluded that the risk of mortality, mortal injury, or recoverable injury for fish with no swim bladders exposed to low frequency active sonar was low, regardless of the distance from the sound source.

A recent study on the behavioral responses of sharks to sensory deterrent devices tested the sharks' attraction to bait while being exposed to auditory and visual stimuli. Ryan et al. (2017) used a strobe light and sound sources within a range thought to be audible to sharks (20 to 2,000 Hz) on captive Port Jackson (*Heterodontus portusjacksoni*) and epaulette (*Hemiscyllium ocelltum*) sharks, and wild great white sharks (*Carcharodon carcharius*). The strobe lights alone (and the lights with sound) reduced the number of times bait was taken by Port Jackson and epaulette sharks. The strobe lights alone did not change white shark behavior, but the sound and the strobe light together led to great white sharks spending less time near bait. Sound alone did not have an effect on great white shark behavior (Ryan et al. 2017). The sound sources used in this study are different than the airguns used in the proposed action, but are still somewhat similar as they are both fairly low frequency sounds.

The precise expected response of ESA-listed elasmobranchs to low-frequency acoustic energy is not completely understood due to a lack of sufficient experimental and observational data for these species. However, given the signal type and level of exposure to the low frequency signals used in seismic survey activities, we do not expect adverse effects (including significant behavioral adjustments, TTS, PTS, injury, or mortality). The most likely response of ESA-listed or proposed elasmobranchs exposed to seismic survey activities, if any, will be minor temporary changes in their behavior including increased swimming rate, avoidance of the sound source, or changes in orientation to the sound source, none of which rise to the level of take. If these behavioral reactions were to occur, we would not expect them to result in fitness impacts such as reduced foraging or reproduction ability.

Therefore, the potential effect of seismic survey activities on the elasmobranch species (giant manta ray and oceanic whitetip shark) listed under the ESA is insignificant. We conclude that the proposed seismic survey activities in the action area are not likely to adversely affect these elasmobranch species because any effects would be insignificant, and these species will not be considered further in this opinion.

7.1.3 Hawksbill Sea Turtle

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical oceans. Small juvenile hawksbills (5 to 21 centimeter [cm] straight carapace length) have been found in association with *Sargassum* spp. in the Atlantic Ocean (Musick and Limpus 1997). Post-oceanic hawksbills are typically associated with coral reefs. There are nesting sites in the Caribbean, including Puerto Rico and the U. S. Virgin Islands, but none in the action area (NMFS and USFWS 2013a).

Hawksbill sea turtles are rare in the mid-Atlantic, with only occasional sightings (Witherington et al. 2012; Witzell 1983). The lack of sighting or bycatch data, as well as the rarity of strandings, leads us to believe that hawksbill sea turtles are unlikely to be in the action area during the proposed seismic surveys (Epperly et al. 2002; Epperly et al. 1996; NMFS 2010a; NMFS 2011a; NMFS 2012a; NMFS 2013a; NMFS 2014; NMFS 2015a; NMFS 2016).

Since the proposed action would take place in an area where we do not expect hawksbill sea turtles to be, we do not expect them to be adversely affected by the proposed action. We therefore conclude that the effects of the proposed action to hawksbill turtles are discountable, and will not be considered further in this opinion.

7.1.4 Atlantic Sturgeon Designated Critical Habitat

On August 17, 2017, NMFS designated critical habitat for all five distinct population segments of Atlantic sturgeon, in coastal rivers from Maine to Florida (82 FR 39160) (Figure 17).

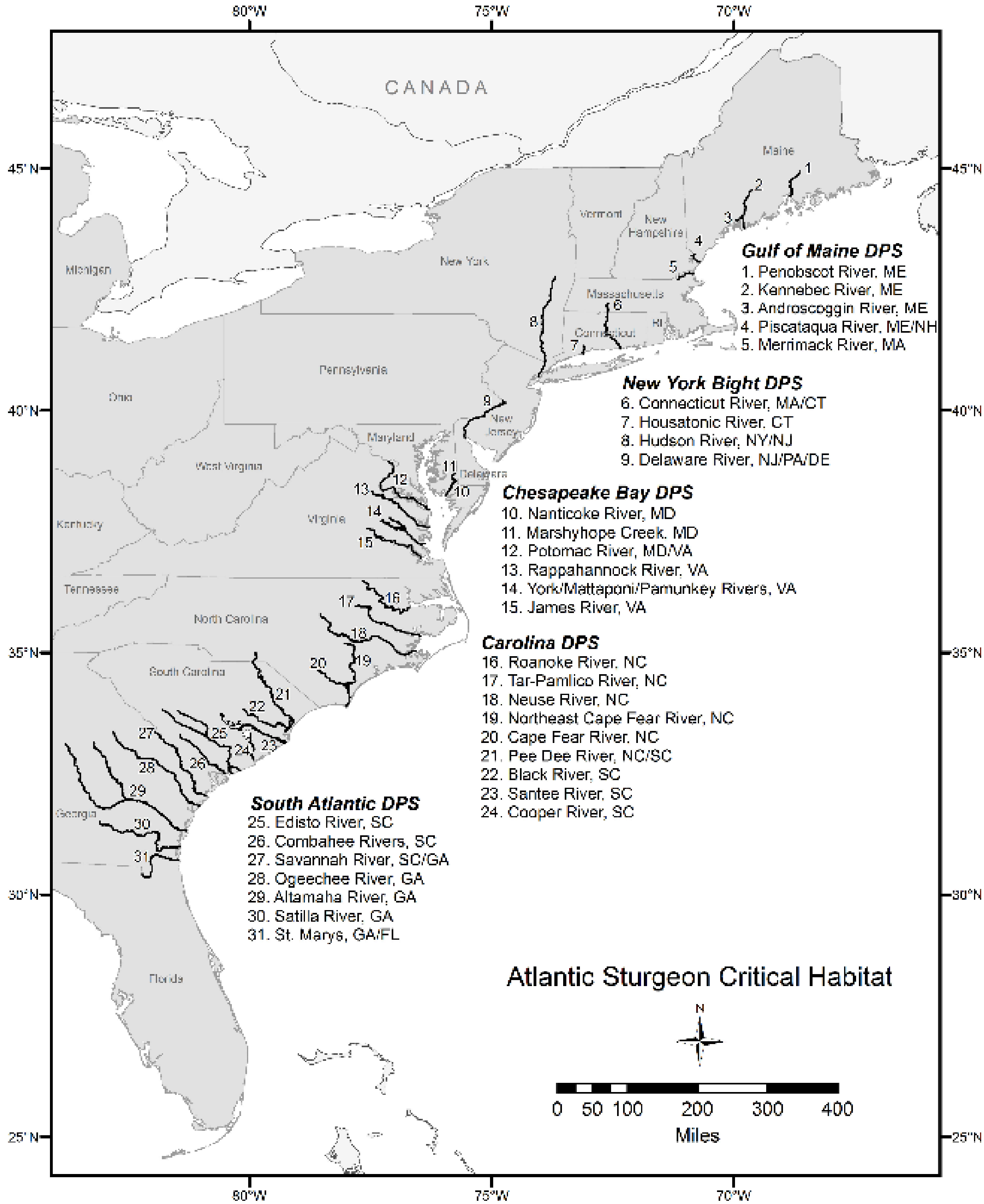

Figure 17. Map showing the 31 coastal rivers designated as critical habitat for Atlantic sturgeon.

The proposed action will take place in the Atlantic Ocean, from Delaware to Cape Canaveral, Florida, in water depths from 50 to 6,000 m deep. Since the proposed action will not take place in the coastal rivers containing designated Atlantic sturgeon critical habitat, we determine that there will be no effect to designated Atlantic sturgeon critical habitat, and it will not be considered further in this opinion.

7.1.5 Loggerhead Turtle (Northwest Atlantic Ocean Distinct Population Segment) Designated Critical Habitat

On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles along the U.S. Atlantic and Gulf of Mexico coasts, from North Carolina to Mississippi (79 FR 39856) (Figure 18). The Final Rule designated five different units of critical habitat, each supporting an essential biological function for loggerhead sea turtles. These units include nearshore reproductive habitat, winter area, *Sargassum*, breeding areas, and migratory corridors. In total, the critical habitat is composed of 38 occupied marine areas and 685 miles of nesting beaches. Loggerhead designated critical habitat occurs within the action area and the potential effects to each unit and its PBFs (see Table 5) are discussed below.

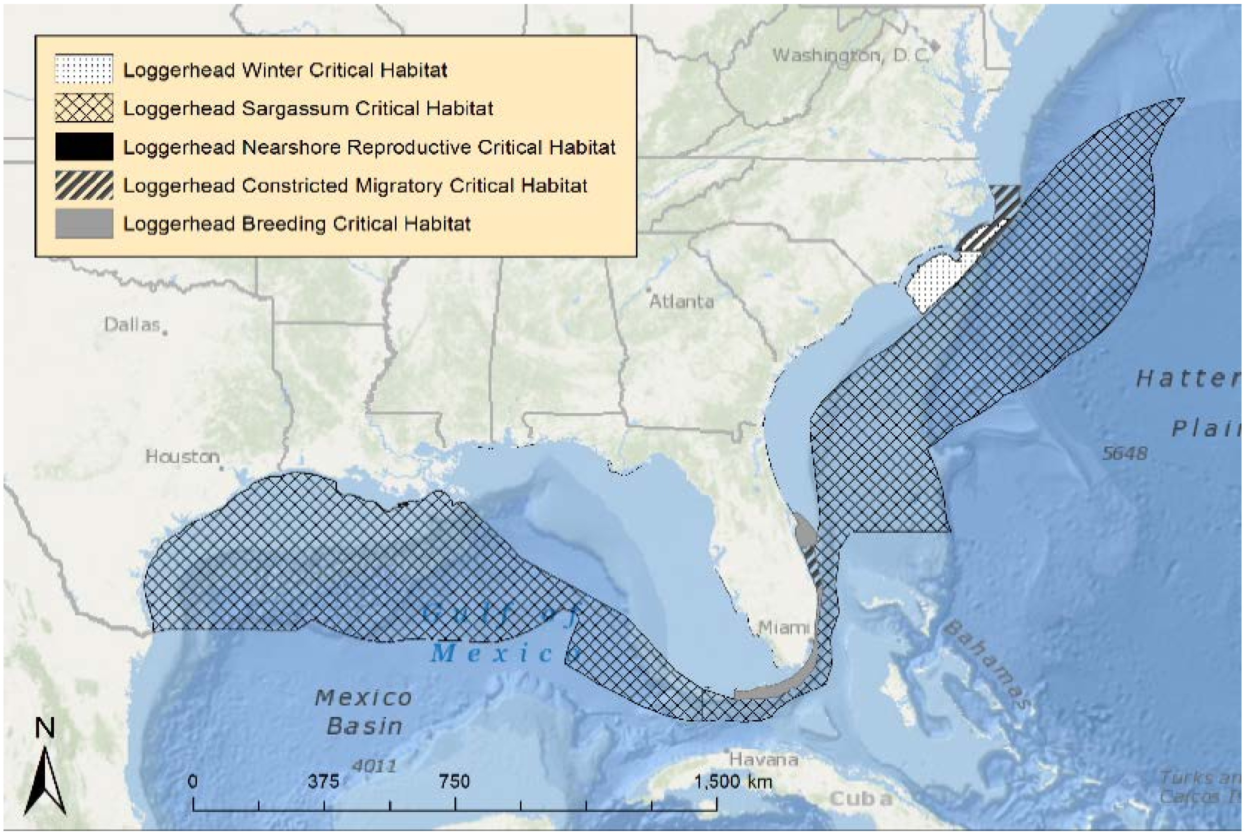

Figure 18. Designated critical habitat for the Northwest Atlantic Ocean Distinct Population Segment of loggerhead sea turtles.

7.1.5.1 Nearshore Reproductive Habitat

Nearshore reproductive habitat units occur in 36 areas from North Carolina to Mississippi. These units extend from the shore to 1.6 km seaward. BOEM's jurisdiction for geophysical activities includes waters between 3 and 200 nautical miles. Since the nearshore reproductive critical habitat units occur outside of where seismic survey would occur, and BOEM cannot permit seismic activity in areas where these critical habitat units are, there will be no effects from seismic airguns. While aircraft and vessels associated with the proposed action may briefly transit nearshore reproductive habitat, we do not believe such transit would affect the PBFs identified in Table 5.

7.1.5.2 Winter Habitat

Winter habitat is designated off North Carolina, from Cape Hatteras to Cape Fear, from the 20 to 100 meter depth contour. The proposed action area falls within this winter habitat. The purpose in designating the winter habitat was to maintain habitat with suitable water temperatures and depths, and continental shelf waters in proximity to the Gulf Stream to support a loggerhead foraging area (Table 5). The eastern and western boundaries of the designated winter habitat are the 20 m and 100 m depth contours, respectively. Nearly all of the winter habitat unit is encompassed in the proposed 90-km North Atlantic right whale closure, and some of it is contained within the 30-km Coastal Closure as well (Figure 19). The North Atlantic right whale closure area would be in effect from November 1 to April 30, covering the period when we expect northern foraging loggerheads to be present in the winter critical habitat unit. ION, TGS, WesternGeco, and Spectrum all have proposed survey lines in the winter habitat unit.

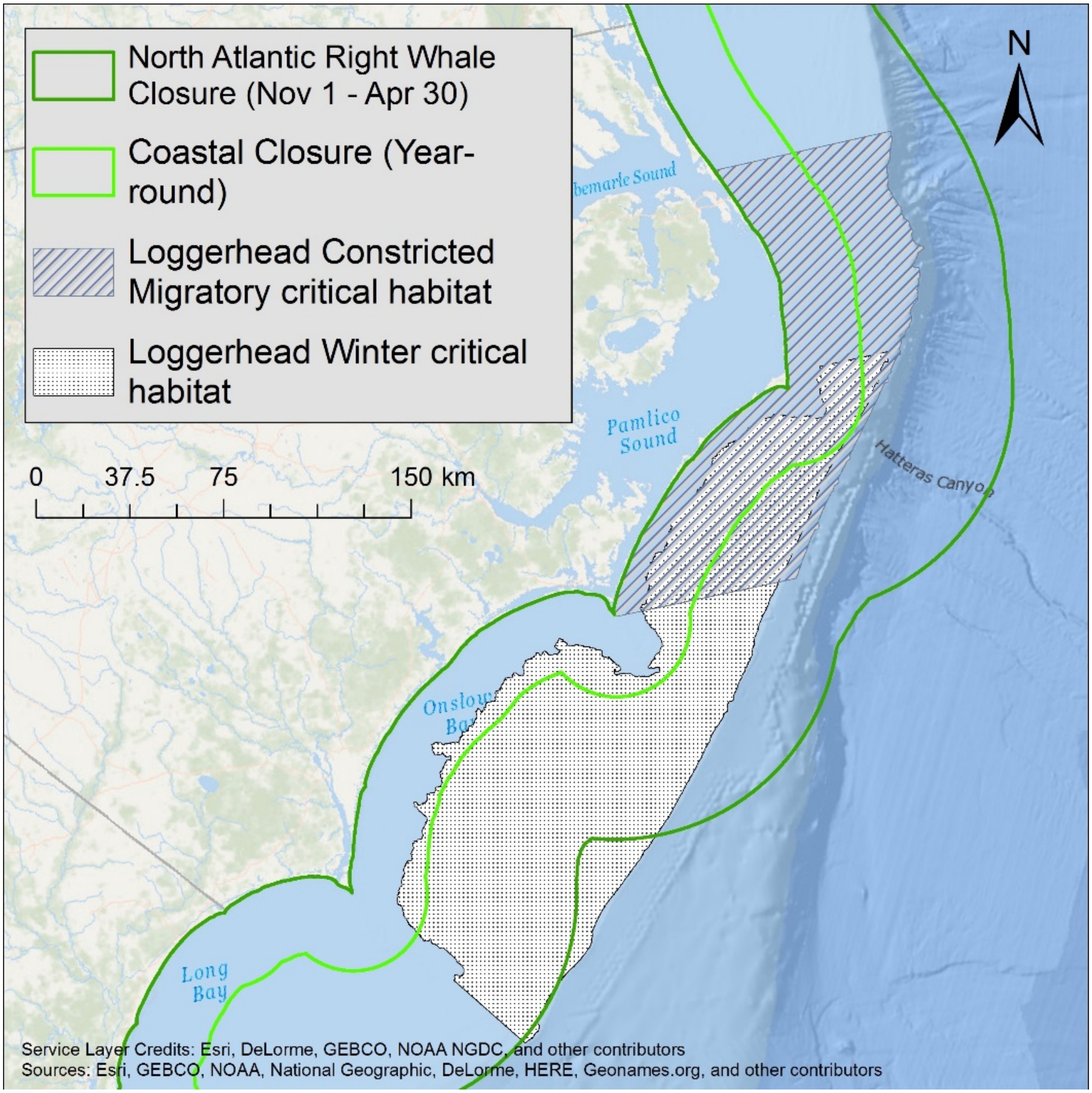

Figure 19. Loggerhead winter and constricted migratory critical habitat units overlapping with the North Atlantic right whale seasonal closure area.

The PBFs for winter habitat are shown in Table 5. The proposed action will include aircraft, vessel, and seismic activity, which will not alter the water temperature or depth of winter habitat, or the proximity to the continental shelf. Therefore, we determine that there will be no effect to loggerhead winter critical habitat as a result of the proposed action.

7.1.5.3 Constricted Migratory Habitat

Loggerhead constricted migratory habitat occurs in the action area (Figure 19). Spectrum, ION, TGS, and Western have proposed survey lines in the constricted migratory critical habitat.

The proposed 90-km North Atlantic right whale closure area would be in effect from November 1 to April 30, and would encompass the entire constricted migratory habitat during that time. Loggerheads migrate through this area northward in the spring (to foraging areas in the mid-Atlantic Bight) and southward in the fall (south of Cape Hatteras) to be in warmer waters (78 FR 43005). Due to the proposed North Atlantic right whale closure, seismic activity would be excluded in this area during the time when we expect most loggerhead use. The proposed Coastal Closure would be in effect year-round and would also encompass part of the designated constricted migratory habitat.

The essential biological features for constricted migratory habitat are listed in Table 5. The constricted migratory breeding habitat will not be exposed to seismic activity from November 1 through April 30 due to the proposed North Atlantic right whale closure. Because loggerheads use this habitat to migrate in fall and spring, roughly coinciding with the timing of the seasonal closure area, the passage conditions of the constricted migratory habitat would not be affected. There is a possibility that loggerheads could use the constricted migratory habitat outside of the year-round Coastal Closure at a time when the North Atlantic right whale closure is not in effect (e.g., earlier in the fall, September or October), and that seismic activities at that time could disrupt passage conditions. We expect that any disruption to passage conditions would be brief, and while it may result in take of loggerhead turtles, it would not have a measurable effect on the PBFs of this habitat. As such, the effects to this designated critical habitat are considered insignificant and we find that the proposed action is not likely to adversely affect designated constricted migratory habitat for loggerhead turtles.

7.1.5.4 Breeding Habitat

Loggerhead breeding critical habitat includes two areas along the Atlantic coast of Florida, and into the Florida Keys. The southern unit starts at the Martin County/Palm Beach County line and extends south to the Marquesas Keys. This area is outside the action area, and is not considered further. The northern portion of the breeding habitat unit is located from near Titusville, Florida, south to Floridana Beach, from the shoreline to depths less than 60 m. The PBFs of the breeding habitat include high densities of reproductive male and female loggerheads, and proximity to the Florida nesting grounds and migratory corridor. The aircraft, vessel, and seismic activities will not affect the proximity to the nesting grounds or migratory corridor. However, any seismic activities in the breeding habitat unit could affect the densities of breeding loggerheads. Loggerhead breeding occurs in late March to early June in the southeastern United States.

There are three proposed closures in the breeding habitat unit. The North Atlantic right whale closure would be in effect from November 1 to April 30 covering part of the expected breeding season. The North Atlantic right whale closure extends from the coast out to 90 km and covers the majority of the designated breeding critical habitat (Figure 20). The second closure area is a sea turtle closure originally proposed by BOEM in their 2014 PEIS for the Mid- and South Atlantic Planning Areas (BOEM 2014a; BOEM 2014b). This closure would prohibit seismic activities from occurring within the time-area closure for nesting sea turtles off shore Brevard County, Florida, which is adjacent to the breeding habitat. The closure season would be in effect from May 1 to October 31 in an area that extends 11 km offshore Brevard County. Loggerhead breeding critical habitat is larger than this closure area, however. The critical habitat extends 14 km from shore to 60 km from shore at its widest point. The third closure area is the 30-km Coastal Closure established to protect bottlenose dolphins. As noted in Section 3.7.1.2, this closure fully encompasses the above Brevard County closure. It will be in effect the entire year essentially eliminating the Brevard County closure. While this closure covers a large portion of the breeding critical habitat, it does not cover the entire unit (Figure 20).

Spectrum, TGS, and ION have proposed survey lines in or near loggerhead breeding habitat (Figure 20). The survey lines that ION and TGS have proposed are very near the loggerhead breeding habitat, and although the lines themselves are not actually inside the boundaries, the area ensonified around those lines during seismic activities may enter into the breeding critical habitat.

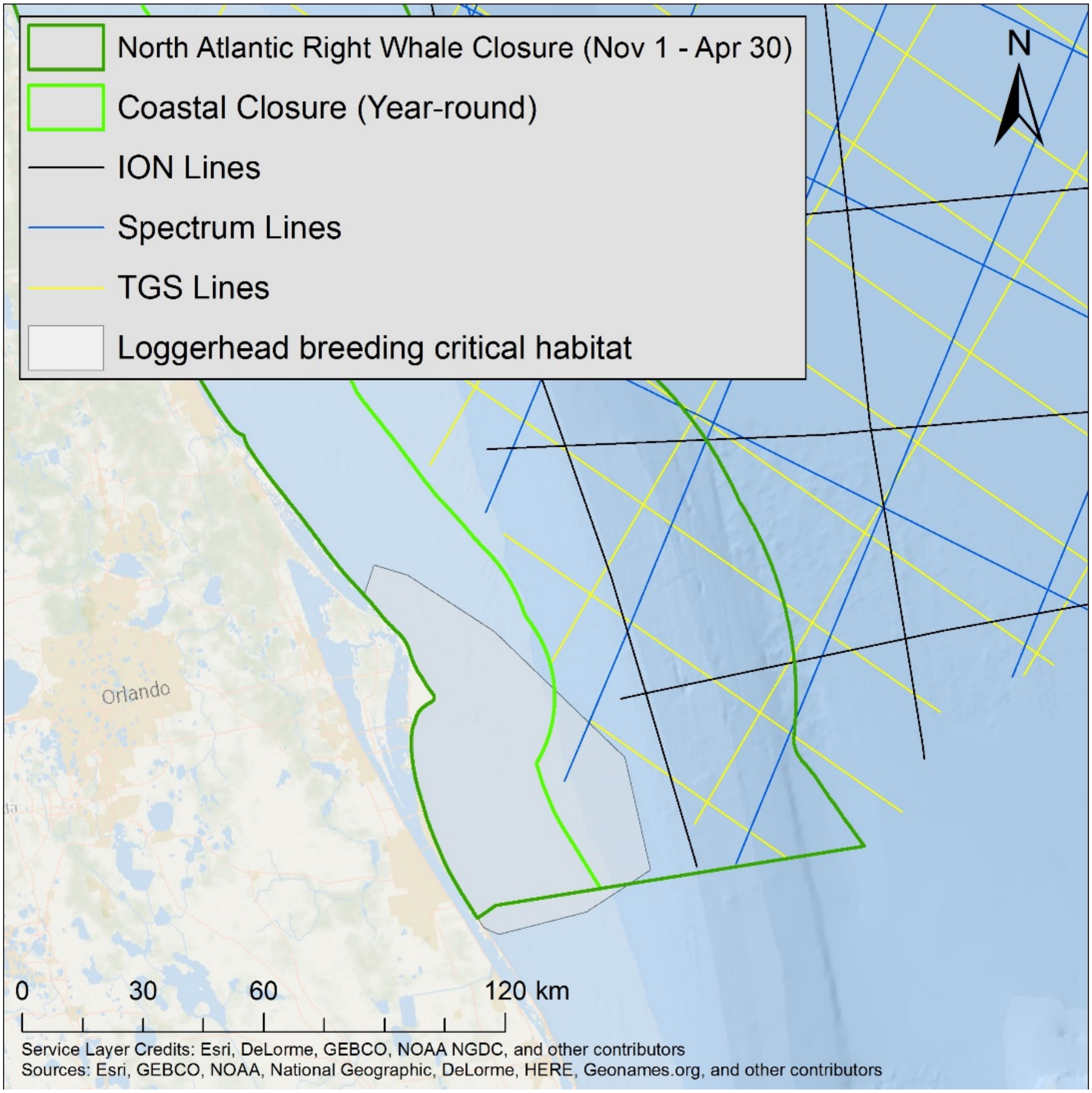

Figure 20. Loggerhead breeding critical habitat and the overlapping closures and seismic survey lines.

There will be a comparatively small amount of survey lines in the breeding habitat unit. Spectrum has a single survey line about 17 km long in breeding habitat. During data acquisition, the vessels would travel at around 4 knots (or 7.4 km per hour), meaning that it would take Spectrum about 2 hours and 20 minutes to complete the survey line in breeding habitat. Similarly, the ION and TGS lines near the breeding critical habitat could be accomplished in a relatively short amount of time (i.e., no more than 5 hours or so).

Given the relatively brief amount of time that seismic activity would occur within breeding habitat, and the small amount of area that would be affected by the proposed action, we do not believe that the proposed action will measurably alter the densities of breeding loggerheads. We expect that loggerheads may be disturbed by the proposed action, but these effects will be temporary and loggerheads will resume activities in the area. Furthermore, such effects directly to individual loggerheads are considered as an effect to the species (i.e., in Section 9 of this opinion). As such, we find that the effects of the proposed action to designated loggerhead breeding critical habitat are insignificant, and the proposed action is not likely to adversely affect this critical habitat.

7.1.5.5 *Sargassum* Habitat

Sargassum habitat overlaps with the action area in the Atlantic Ocean, where it occurs from the northern/western boundary of the Gulf Stream to the east edge of the U.S. EEZ. The proposed action will involve aircraft, vessel, and seismic activity. These activities are not expected to affect most of the PBFs for loggerhead *Sargassum* critical habitat identified in Table 5.

However, recent evidence indicates that seismic airguns may lead to a significant reduction in zooplankton, including copepods. McCauley et al. (2017) found that the use of a single airgun lead to a decrease in zooplankton abundance by over 50 percent and a two- to three-fold increase in dead adult and larval zooplankton when compared to control scenarios. In addition, effects were found out to 1.2 km, the maximum distance to which the sonar equipment used in the study was able to detect changes in abundance. McCauley et al. (2017) noted that for seismic activities to have a significant impact on zooplankton at an ecological scale, the spatial or temporal scale of the seismic activity must be large in comparison to the ecosystem in question. In particular, 3-D seismic surveys, which involve the use of multiple overlapping tracklines to extensively and intensively survey a particular area, are of concern (McCauley et al. 2017). This is in part because for such activities to have a measurable effect, they need to outweigh the naturally fast turnover rate of zooplankton (McCauley et al. 2017).

Given the results from McCauley et al. (2017) and that copepod prey are identified as being part of one PBF of loggerhead *Sargassum* critical habitat, it is possible that the proposed action may affect designated loggerhead *Sargassum* critical habitat. The majority of copepod prey available to loggerhead sea turtles in *Sargassum* habitat are expected to be near the surface (Witherington et al. 2012), but results of McCauley et al. (2017) provide little information on the effects to copepods at the surface since their analyses excluded zooplankton at the surface bubble layer. Nonetheless, given that airguns primarily transmit sound downward, and that those associated with the proposed action would be towed at depths between 6 to 10 m, we expect that sounds from seismic airguns would be relatively low at the surface and as such, would effects copepod prey in *Sargassum* critical habitat less than that reported in McCauley et al. (2017). We also anticipate that seismic survey operators would actively avoid *Sargassum* patches within the action area, as coming near or in contact with any *Sargassum* may destroy the towed seismic equipment, and at the very least may cause a loss in data so that crew can disentangle *Sargassum* from the seismic equipment. Nevertheless, since effects to zooplankton have been observed out to 1.2 km (McCauley et al. 2017), the avoidance of *Sargassum* patches may not entirely prevent effects to copepods in nearby *Sargassum* patches. However, in contrast to the intensive 3-D seismic surveys discussed in McCauley et al. (2017), the proposed seismic surveys are 2-D, and are designed as exploratory surveys, covering a large area in a relatively short amount of time. Such surveys are less likely to have significant effects on zooplankton given the high turnover rate of zooplankton and the currents in the North Atlantic gyre and the Gulf Stream, which would circulate *Sargassum* into designated loggerhead *Sargassum* critical habitat within the action area (see Richardson et al. 2017 for simulations based on the results of McCauley et al. 2017 that suggest ocean circulation greatly reduce the impact of seismic surveys on zooplankton at the population level)

In summary, while the proposed seismic surveys may temporarily alter copepod abundance in designated loggerhead *Sargassum* critical habitat, we expect such effects to be insignificant because 1) most copepods would be near the surface where sound from seismic airguns is expected to be relatively low, 2) seismic survey operators would actively avoid *Sargassum* patches, and 3) the high turnover rate of zooplankton and ocean circulation would to minimize any effects. Therefore, we find that the proposed action is not likely to adversely affect designated loggerhead *Sargassum* critical habitat because any effects would be insignificant.

Table 5. Essential physical or biological features for loggerhead critical habitat units.

Loggerhead critical habitat unit	Essential Biological Features
Nearshore Reproductive Habitat	1. Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 C.F.R. §17.95(c) to 1.6 km (1 mile) offshore. 2. Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water. 3. Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.
Winter Habitat	1. Water temperatures above 10° C from November through April. 2. Continental shelf waters in proximity to the western boundary of the Gulf Stream. 3. Water depths between 20 and 100 m.
Breeding Habitat	1. High densities of reproductive male and female loggerheads. 2. Proximity to primary Florida migratory corridor. 3. Proximity to Florida nesting grounds.
Migratory Habitat	1. Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways. 2. Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.
Sargassum Habitat	1. Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the *Sargassum* community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerheads. 2. *Sargassum* in concentrations that support adequate prey abundance and cover. 3. Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods. 4. Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., >10 m depth.

7.1.6 North Atlantic Right Whale Designated Critical Habitat

On January 27, 2016, NMFS issued a final rule expanding North Atlantic right whale critical habitat (81 FR 4837). This expansion included new areas in the Gulf of Maine (near Maine, New Hampshire, and Massachusetts) and Georges Bank region and off the Southeast U.S. Coast Calving Area, from southern North Carolina to central Florida. The Southeast U.S. Coast Calving Area unit was designated to provide essential features to support North Atlantic right whale calving and nursing season, which typically occurs from November 15 to April 15 annually.

The proposed action will take place from Delaware to Cape Canaveral, Florida. The Gulf of Maine unit of North Atlantic right whale critical habitat is out of the range of the proposed action area, and thus will not be affected. The Southeast U.S. Coast Calving Area unit of critical habitat is near the proposed action area. However, the proposed North Atlantic right whale closure would limit seismic surveys during critical times within and in proximity to North Atlantic right whale critical habitat. Seismic surveys would not be permitted within the North Atlantic right whale closure from November 1 to April 30, and this closure encompasses the entire Southeast U.S. Coast Calving Area critical habitat (Figure 21). Furthermore, the Coastal Closure encompasses much of the Southeast U.S. Coast Calving Area critical habitat and would prevent all seismic surveys within this area (Figure 21). Nonetheless, when the North Atlantic right whale closure is not active, a portion of the Southeast U.S. Coast Calving Area critical habitat may be exposed to seismic survey activities.

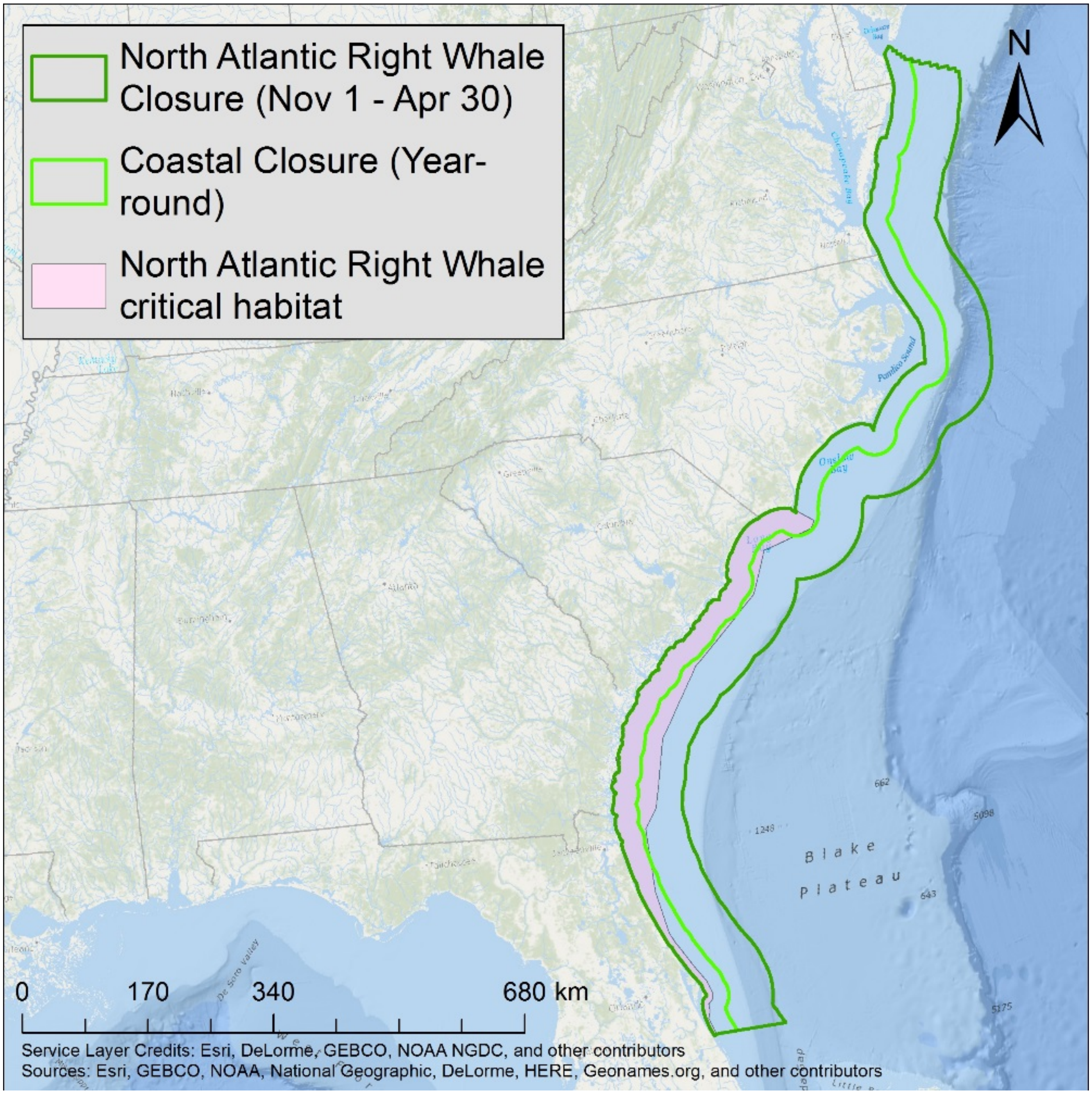

Figure 21. Map showing North Atlantic right whale Calving Area critical habitat and the proposed closure areas.

In the Final Rule, NMFS did not identify seismic activity as an activity that would impact the essential features of critical habitat. Rather, seismic activity was categorized as an issue related to the potential taking of North Atlantic right whales, as considered later in this opinion. The PBFs of the North Atlantic right whale Calving Area unit are:

1. Sea surface conditions associated with Force 4 or less on the Beaufort scale.
2. Sea surface temperatures of 7° to 17° Celsius.

3. Water depths of 6 to 28 m where these features simultaneously co-occur over contiguous areas of at least 231 square nautical miles of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves.

Possible stressors associated with the proposed seismic surveys include those associated with aircraft and vessel activity (pollution, vessel strike, acoustic and visual disturbance, and entanglement), and with the seismic airguns and echosounders (acoustic disturbance). However, even in the portion of the Southeast U.S. Coast Calving Area critical habitat that may be exposed to seismic survey activities, we do not believe these stressors will affect the PBFs. They will not alter the sea surface conditions or temperatures, or water depths. Therefore, we conclude that the proposed action will have no effect on North Atlantic right whale Calving Area critical habitat, and effects to this designated critical habitat will not be discussed further in this opinion.

7.2 Species and Critical Habitat Likely to be Adversely Affected

This section examines the status of each species that are likely to be adversely affected by the proposed action. The status includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the Federal Register, status reviews, recovery plans, and on NMFS' website: (https://www.fisheries.noaa.gov/species-directory/threatened-endangered), among others.

This section also examines the condition of critical habitat throughout the designated area (such as various coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the PBFs that contribute to that conservation value of the critical habitat.

7.2.1 Blue Whale

The blue whale is a widely distributed baleen whale found in all major oceans (Figure 22).

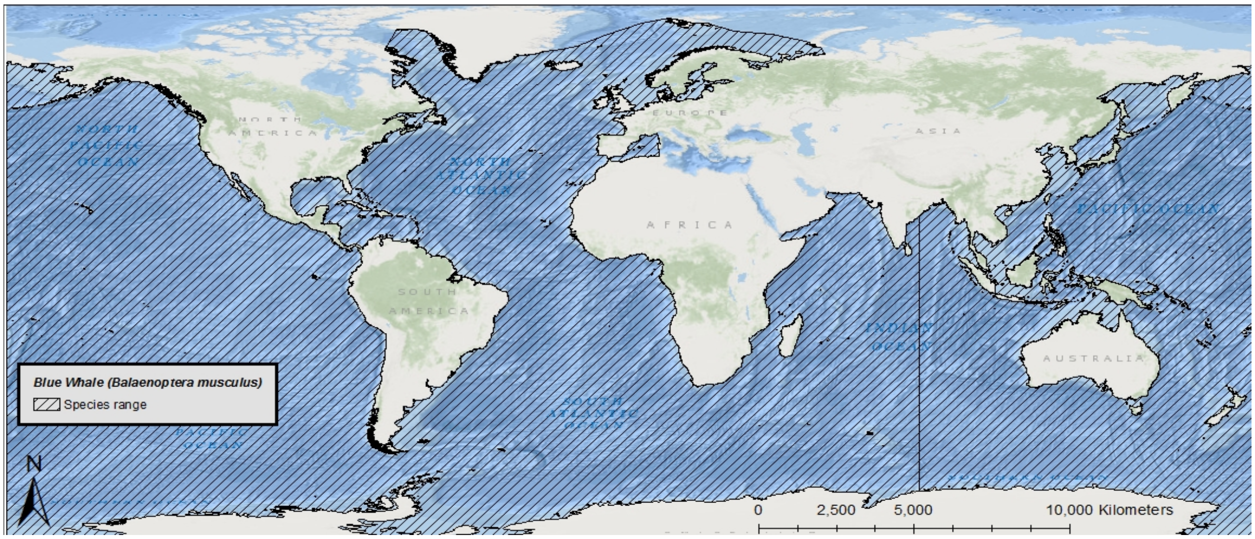

Figure 22. Map identifying the range of the endangered blue whale.

Blue whales are the largest animal on earth and distinguishable from other whales by a long-body and comparatively slender shape, a broad, flat "rostrum" when viewed from above, proportionally smaller dorsal fin, and are a mottled gray color that appears light blue when seen through the water. Most experts recognize at least three subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific. The blue whale was originally listed as endangered on December 2, 1970 (Table 3).

Information available from the recovery plan (NMFS 1998), recent stock assessment reports (Carretta et al. 2018; Hayes et al. 2018b; Muto et al. 2018), and status review (COSEWIC 2002) were used to summarize the life history, population dynamics and status of the species as follows.

7.2.1.1 Life History

The average life span of blue whales is 80 to 90 years. They have a gestation period of 10 to 12 months, and calves nurse for six to seven months. Blue whales reach sexual maturity between five and 15 years of age with an average calving interval of two to three years. They winter at low latitudes, where they mate, calve and nurse, and summer at high latitudes, where they feed. Blue whales forage almost exclusively on krill and can eat approximately 3,600 kilograms daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90 to 120 m.

7.2.1.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the blue whale.

The global, pre-exploitation estimate for blue whales is approximately 181,200 (IWC 2007b). Current estimates indicate approximately 5,000 to 12,000 blue whales globally (IWC 2007b). Blue whales are separated into populations by ocean basin in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. There are three stocks of blue whales designated in U.S. waters: the Eastern North Pacific Ocean (N = 1,647; N_{min} = 1,551), Central North Pacific Ocean (N = 133; N_{min} = 63), and Western North Atlantic Ocean (N = 400 to 600; N_{min} = 440). In the Southern Hemisphere, the latest abundance estimate for Antarctic blue whales is 2,280 individuals in 1997/1998 [95 percent confidence intervals 1,160 to 4,500 (Branch 2007)].

Current estimates indicate the Eastern North Pacific stock shows no signs of population growth since the early 1990s, perhaps because the population is nearly at carry capacity (Carretta et al. 2018). An overall population growth rate for the species or growth rates for the two other individual U.S. stocks are not available at this time. In the Southern Hemisphere, population growth estimates are available only for Antarctic blue whales, which estimate a population growth rate of 8.2 percent per year (95 percent confidence interval 1.6 to 14.8 percent, Branch 2007).

Little genetic data exist on blue whales globally. Data from Australia indicates that at least populations in this region experienced a recent genetic bottleneck, likely the result of commercial whaling, although genetic diversity levels appear to be similar to other, non-threatened mammal species (Attard et al. 2010). Consistent with this, data from Antarctica also demonstrate this bottleneck but high haplotype diversity, which may be a consequence of the recent timing of the bottleneck and blue whales long lifespan (Sremba et al. 2012). Data on genetic diversity of blue whales in the Northern Hemisphere are currently unavailable. However, genetic diversity information for similar cetacean population sizes can be applied. Stocks that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Stocks that have a total population 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Stock populations at low densities (<100) are more likely to suffer from the ‘Allee’ effect, where inbreeding and the heightened difficulty of finding mates reduces the population growth rate in proportion with reducing density.

In general, blue whale distribution is driven largely by food requirements; blue whales are more likely to occur in waters with dense concentrations of their primary food source, krill. While they can be found in coastal waters, they are thought to prefer waters further offshore. In the North Atlantic Ocean, the blue whale range extends from the subtropics to the Greenland Sea. They are most frequently sighted in waters off eastern Canada with a majority of sightings taking place in the Gulf of St. Lawrence. In the North Pacific Ocean, blue whales range from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California to Costa Rica in the east. They primarily occur off the Aleutian Islands and the Bering Sea. In the northern Indian Ocean, there is a "resident" population of blue whales with sightings being reported from the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca. In the Southern Hemisphere, distributions of subspecies (*B. m. intermedia* and *B. m. brevicauda*) seem to be segregated. The subspecies *B. m. intermedia* occurs in relatively high latitudes south of the "Antarctic Convergence" (located between 48°S and 61°S latitude) and close to the ice edge. The subspecies *B. m. brevicauda* is typically distributed north of the Antarctic Convergence.

7.2.1.3 Vocalizations and Hearing

Blue whale vocalizations tend to be long (greater than 20 seconds), low frequency (less than 100 Hz) signals (Thomson and Richardson 1995), with a range of 12 to 400 Hz and dominant energy in the infrasonic range of 12 to 25 Hz (Ketten 1998; McDonald et al. 2001; McDonald et al. 1995; Mellinger and Clark 2003). Vocalizations are predominantly songs and calls.

Calls are short-duration sounds (two to five seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (20 to 80 Hz), with seasonally variable occurrence. Blue whale calls have high acoustic energy, with reports of source levels ranging from 180 to 195 dB re: 1 µPa at 1 m (Aburto et al. 1997; Berchok et al. 2006; Clark and Gagnon 2004; Cummings and Thompson 1971; Ketten 1998; McDonald et al. 2001; Samaran et al. 2010). Calling rates of blue whales tend to vary based on feeding behavior. For example, blue whales make seasonal migrations to areas of high productivity to feed, and vocalize less at the feeding grounds then during migration (Burtenshaw et al. 2004). Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging followed by an increase at dusk as prey moved up into the water column and dispersed. Oleson et al. (2007c) reported higher calling rates in shallow diving (less than 30 m whales), while deeper diving whales (greater than 50 m) were likely feeding and calling less.

Although general characteristics of blue whale calls are shared in distinct regions (McDonald et al. 2001; Mellinger and Clark 2003; Rankin et al. 2005; Thompson et al. 1996), some variability appears to exist among different geographic areas (Rivers 1997). Sounds in the North Atlantic Ocean have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Berchok et al. 2006; Mellinger and Clark 2003; Samaran et al. 2010). Clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific Ocean have also been reported (Stafford et al. 2001); however, some overlap in calls from the geographically distinct regions have been observed, indicating that the whales may have the ability to mimic calls (Stafford and Moore 2005). In Southern California, blue whales produce three known call types: Type A, B, and D. B calls are stereotypic of blue whale population found in the eastern North Pacific (McDonald et al. 2006b) and are produced exclusively by males and associated with mating behavior (Oleson et al. 2007a). These calls have long durations (20 seconds) and low frequencies (10 to 100 Hz); they are produced either as repetitive sequences (song) or as singular calls. The B call has a set of harmonic tonals, and may be paired with a pulsed Type A call. D calls are produced in highest numbers during the late spring and early summer and in diminished numbers during the fall, when A-B song dominates blue whale calling (Hildebrand et al. 2011; Hildebrand et al. 2012; Oleson et al. 2007c).

Blue whale songs consist of repetitively patterned vocalizations produced over time spans of minutes to hours or even days (Cummings and Thompson 1971; McDonald et al. 2001). The songs are divided into pulsed/tonal units, which are continuous segments of sound, and phrases, repeated in combinations of one to five units (Mellinger and Clark 2003; Payne and McVay 1971). Songs can be detected for hundreds, and even thousands of kilometers (Stafford et al. 1998), and have only been attributed to males (McDonald et al. 2001; Oleson et al. 2007a). Worldwide, songs are showing a downward shift in frequency (McDonald et al. 2009). For example, a comparison of recording from November 2003 and November 1964 and 1965 reveals a long-term shift in the frequency of blue whale calling near San Nicolas Island. In 2003, the spectral energy peak was 16 Hz compared to approximately 22.5 Hz in 1964 and 1965, illustrating a more than 30 percent shift in call frequency over four decades (McDonald et al. 2006b). McDonald et al. (2009) observed a 31 percent downward frequency shift in blue whale calls off the coast of California, and also noted lower frequencies in seven of the world's 10 known blue whale songs originating in the Atlantic, Pacific, Southern, and Indian Oceans. Many possible explanations for the shifts exist but none has emerged as the probable cause.

As with other baleen whale vocalizations, blue whale vocalization function is unknown, although numerous hypotheses exist (maintaining spacing between individuals, recognition, socialization, navigation, contextual information transmission, and location of prey resources) (Edds-Walton 1997; Oleson et al. 2007b; Payne and Webb 1971; Thompson et al. 1992). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently while in summer high-latitude feeding areas. Short, rapid sequences of 30 to 90 Hz calls are associated with socialization and may be displays by males based upon call seasonality and structure. The low frequency sounds produced by blue whales can, in theory, travel long distances, and it is possible that such long distance communication occurs (Edds-Walton 1997; Payne and Webb 1971). The long-range sounds may also be used for echolocation in orientation or navigation (Tyack 1999).

Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low-frequency sounds below 400 Hz (Croll et al. 2001; Oleson et al. 2007c; Stafford and Moore 2005). In terms of functional hearing capability, blue whales belong to the low frequency group, which have a hearing range of 7 Hz to 35 kHz (NOAA 2018).

7.2.1.4 Status

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were harvested from the late nineteenth to mid-twentieth centuries. In the North Pacific Ocean, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs, but blue whales are threatened by vessel strikes, entanglement in fishing gear, pollution, harassment due to whale watching, and reduced prey abundance and habitat degradation due to climate change. Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

7.2.1.5 Critical Habitat

No critical habitat has been designated for the blue whale.

7.2.1.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover blue whale populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 1998 Final Recovery Plan for the Blue whale for complete down listing/delisting criteria for each of the following recovery goals.

1. Determine stock structure of blue whale populations occurring in U.S. waters and elsewhere
2. Estimate the size and monitor trends in abundance of blue whale populations
3. Identify and protect habitat essential to the survival and recovery of blue whale populations
4. Reduce or eliminate human-caused injury and mortality of blue whales
5. Minimize detrimental effects of directed vessel interactions with blue whales
6. Maximize efforts to acquire scientific information from dead, stranded, and entangled blue whales
7. Coordinate state, federal, and international efforts to implement recovery actions for blue whales
8. Establish criteria for deciding whether to delist or downlist blue whales

7.2.2 Fin Whale

The fin whale is a large, widely distributed baleen whale found in all major oceans and comprised of three subspecies: *B. p. physalus* in the Northern Hemisphere, and *B. p. quoyi* and *B. p. patachonica* (a pygmy form) in the Southern Hemisphere (Figure 23).

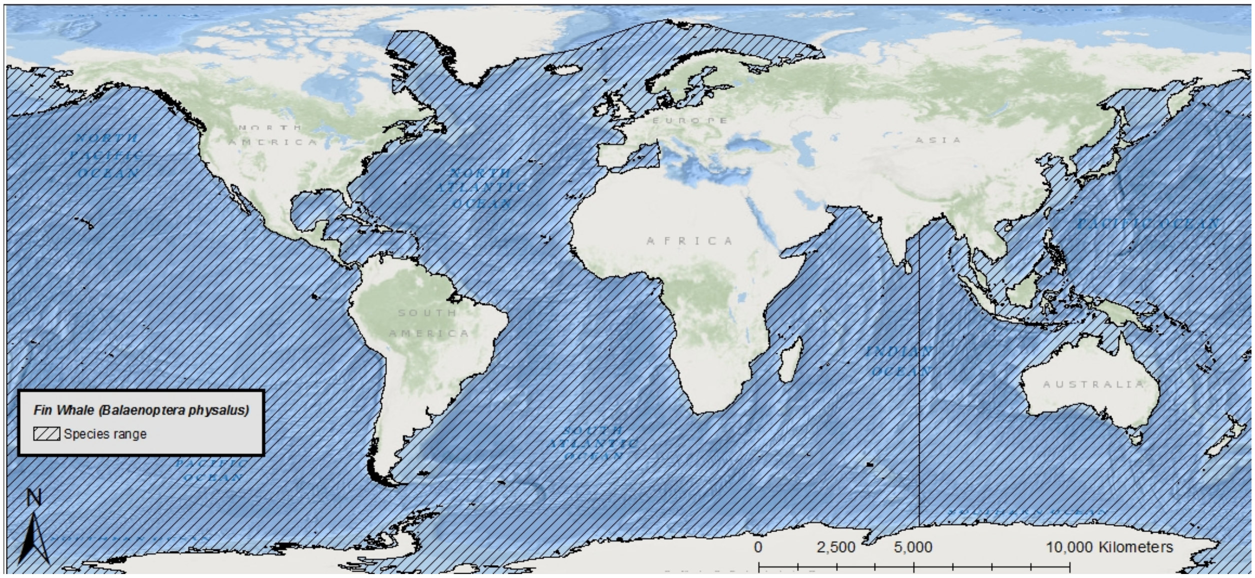

Figure 23. Map identifying the range of the endangered fin whale.

Fin whales are distinguishable from other whales by a sleek, streamlined body, with a V-shaped head, a tall falcate dorsal fin, and a distinctive color pattern of a black or dark brownish-gray body and sides with a white ventral surface. The lower jaw is gray or black on the left side and creamy white on the right side. The fin whale was originally listed as endangered on December 2, 1970 (Table 3).

Information available from the recovery plan (NMFS 2010c), recent stock assessment reports (Carretta et al. 2018; Hayes et al. 2018b; Muto et al. 2018) and status review (NMFS 2011b) were used to summarize the life history, population dynamics and status of the species as follows.

7.2.2.1 Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between six and 10 years of age with an average calving interval of two to three years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed, although some fin whales appear to be residential to certain areas. Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lice.

7.2.2.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the fin whale.

The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000 to 45,000 (Ohsumi and Wada 1974). In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. Approximately 704,000 fin whales were killed in the Southern Hemisphere from 1904 to 1975. Of the three to seven stocks thought to occur in the North Atlantic Ocean (approximately 50,000 individuals), one occurs in U.S. waters, where NMFS' best estimate of abundance is 1,618 individuals (N_{min}=1,234); however, this may be an underrepresentation as the entire range of the stock was not surveyed (Palka 2012). There are three stocks in U.S. Pacific Ocean waters: Northeast Pacific (N= 3,168; N_{min}=2,554), Hawaii (approximately 154 individuals, N_{min}=75) and California/Oregon/Washington (approximately 9,029 individuals, N_{min}=8,127) (Nadeem et al. 2016). The International Whaling Commission (IWC) also recognizes the China Sea stock of fin whales, found in the Northwest Pacific Ocean, which currently lacks an abundance estimate (Reilly et al. 2013). Abundance data for the Southern Hemisphere stock are limited; however, there were assumed to be somewhat more than 15,000 in 1983 (Thomas et al. 2016).

Current estimates indicate approximately 10,000 fin whales in U.S. Pacific Ocean waters, with an annual growth rate of 4.8 percent in the Northeast Pacific stock and a stable population abundance in the California/Oregon/Washington stock (Nadeem et al. 2016). Overall population growth rates and total abundance estimates for the Hawaii stock, China Sea stock, western North Atlantic stock, and Southern Hemisphere fin whales are not available at this time.

Archer et al. (2013) recently examined the genetic structure and diversity of fin whales globally. Full sequencing of the mitochondrial DNA genome for 154 fin whales sampled in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least at this geographic scale. However, North Atlantic fin whales appear to be more closely related to the Southern Hemisphere population, as compared to fin whales in the North Pacific Ocean, which may indicate a revision of the subspecies delineations is warranted. Generally speaking, haplotype diversity was found to be high both within ocean basins, and across. Such high genetic diversity and lack of differentiation within ocean basins may indicate that despite some populations having small abundance estimates, the species may persist long-term and be somewhat protected from substantial environmental variance and catastrophes.

There are over 100,000 fin whales worldwide, occurring primarily in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere where they appear to be reproductively isolated. The availability of prey, sand lice in particular, is thought to have had a strong influence on the distribution and movements of fin whales.

7.2.2.3 Vocalizations and Hearing

Fin whales produce a variety of low frequency sounds in the 10 to 200 Hz range (Edds 1988; Thompson et al. 1992; Watkins 1981; Watkins et al. 1987). Typical vocalizations are long, patterned pulses of short duration (0.5 to two seconds) in the 18 to 35 Hz range, but only males are known to produce these (Clark et al. 2002; Patterson and Hamilton 1964). The most typically recorded call is a 20 Hz pulse lasting about one second, and reaching source levels of 189 ± 4 dB re: 1 µPa at 1 m (Charif et al. 2002; Clark et al. 2002; Edds 1988; Garcia et al. 2018; Richardson et al. 1995; Sirovic et al. 2007; Watkins 1981; Watkins et al. 1987). These pulses frequently occur in long sequenced patterns, are down swept (e.g., 23 to 18 Hz), and can be repeated over the course of many hours (Watkins et al. 1987). In temperate waters, intense bouts of these patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clark and Charif 1998). Richardson et al. (1995) reported this call occurring in short series during spring, summer, and fall, and in repeated stereotyped patterns in winter. The seasonality and stereotype nature of these vocal sequences suggest that they are male reproductive displays (Watkins 1981; Watkins et al. 1987); a notion further supported by data linking these vocalizations to male fin whales only (Croll et al. 2002). In Southern California, the 20 Hz pulses are the dominant fin whale call type associated both with call-counter-call between multiple animals and with singing (U.S. Navy 2010; U.S. Navy 2012). An additional fin whale sound, the 40 Hz call described by Watkins (1981), was also frequently recorded, although these calls are not as common as the 20 Hz fin whale pulses. Seasonality of the 40 Hz calls differed from the 20 Hz calls, since 40 Hz calls were more prominent in the spring, as observed at other sites across the northeast Pacific Ocean (Sirovic et al. 2012). Source levels of Eastern Pacific Ocean fin whale 20 Hz calls has been reported as 189 ± 5.8 dB re: 1 µPa at 1 m (Weirathmueller et al. 2013). Some researchers have also recorded moans of 14 to 118 Hz, with a dominant frequency of 20 Hz, tonal and upsweep vocalizations of 34 to 150 Hz, and songs of 17 to 25 Hz (Cummings and Thompson 1994; Edds 1988; Garcia et al. 2018; Watkins 1981). In general, source levels for fin whale vocalizations are 140 to 200 dB re: 1 µPa at 1 m (see also Clark and Gagnon 2004; as compiled by Erbe 2002). The source depth of calling fin whales has been reported to be about 50 m (Watkins et al. 1987). Although acoustic recordings of fin whales from many diverse regions show close adherence to the typical 20-Hz bandwidth and sequencing when performing these vocalizations, there have been slight differences in the pulse patterns, indicative of some geographic variation (Thompson et al. 1992; Watkins et al. 1987).

Although their function is still in doubt, low frequency fin whale vocalizations travel over long distances and may aid in long distance communication (Edds-Walton 1997; Payne and Webb 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpback whales (Croll et al. 2002). These vocal bouts last for a day or longer (Tyack 1999). Also, it has been suggested that some fin whale sounds may function for long range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

Direct studies of fin whale hearing have not been conducted, but it is assumed that fin whales can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995). This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997). In a study using computer tomography scans of a calf fin whale skull, Cranford and Krysl (2015) found sensitivity to a broad range of frequencies between 10 Hz and 12 kHz and a maximum sensitivity to sounds in the 1 to 2 kHz range. In terms of functional hearing capability, fin whales belong to the low-frequency group, which have a hearing range of 7 Hz to 35 kHz (NOAA 2018).

7.2.2.4 Status

The fin whale is endangered as a result of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. Fin whales may be killed under "aboriginal subsistence whaling" in Greenland, under Japan's scientific whaling program, and Iceland's formal objection to the International Whaling Commission's ban on commercial whaling. Additional threats include vessel strikes, reduced prey availability due to overfishing or climate change, and sound. The species' overall large population size may provide some resilience to current threats, but trends are largely unknown.

7.2.2.5 Critical Habitat

No critical habitat has been designated for the fin whale.

7.2.2.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover fin whale populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2010 Final Recovery Plan for the fin whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable population in all ocean basins.
2. Ensure significant threats are addressed.

7.2.3 North Atlantic Right Whale

The North Atlantic right whale is a narrowly distributed baleen whale found in temperate and sub-polar latitudes in the North Atlantic Ocean (Figure 24). Today they are mainly found in the Western North Atlantic, but have been historically recorded south of Greenland and in the Denmark straight, as well as in Eastern North Atlantic waters (Kraus and Rolland 2007) with possible historic calving grounds being located in the Mediterranean Sea (Rodrigues et al. 2018).

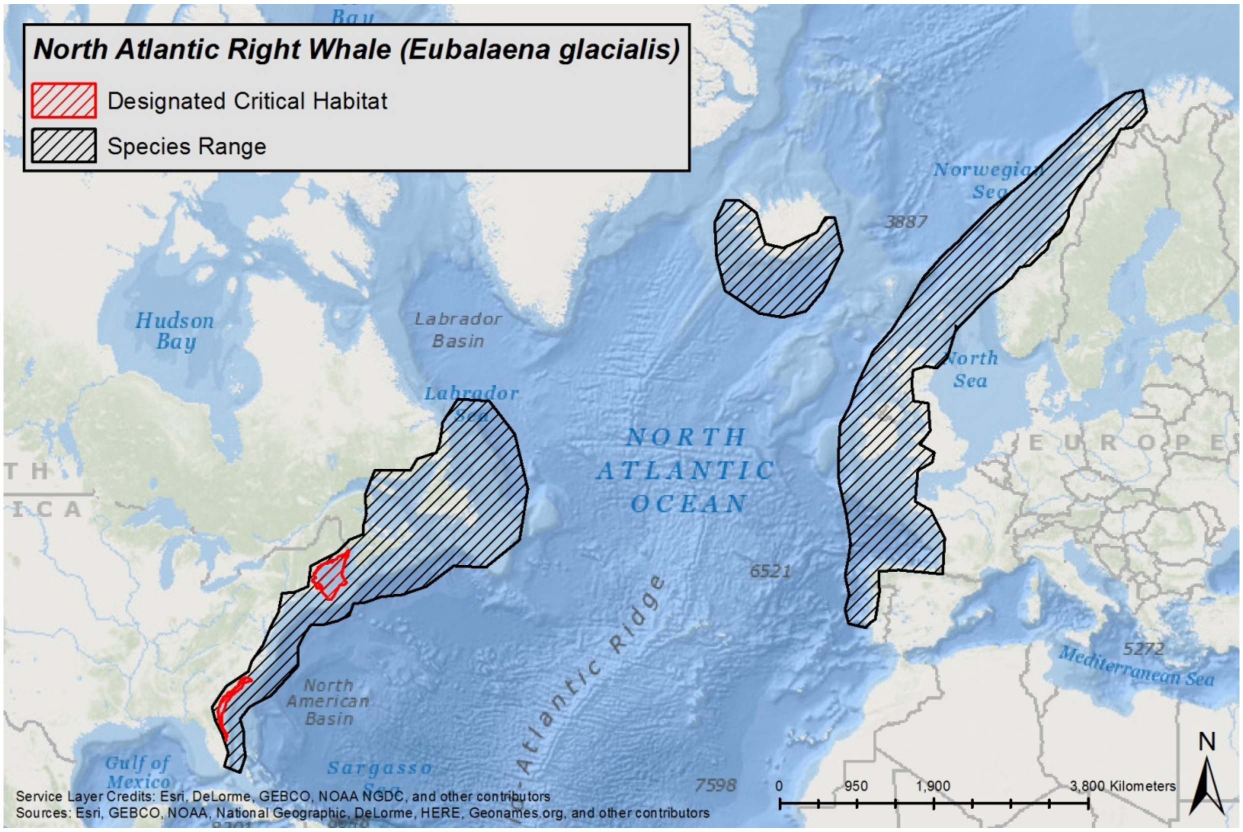

Figure 24: Map identifying the approximate historic range and currently designated U.S. critical habitat of the North Atlantic right whale.

The North Atlantic right whale is distinguished by its stocky body and lack of a dorsal fin. The species was originally listed as endangered on December 2, 1970 (Table 3).

We used information available in the most recent five-year review (NMFS 2017h), the most recent stock assessment report (Hayes et al. 2018b), and the scientific literature to summarize the species, as follows.

7.2.3.1 Life history

The maximum lifespan of North Atlantic right whales is unknown, but one individual is thought to have reached around 70 years of age (Hamilton et al. 1998; Kenney 2009). Previous modelling efforts suggest that in 1980, females had a life expectancy of approximately 52 years of age, which was twice that of males at the time (Fujiwara and Caswell 2001). However, due to reduced survival probability (Caswell et al. 1999), in 1995 female life expectancy was estimated to have declined to approximately 15 years, with males having a slightly higher life expectancy into the 20s (Fujiwara and Caswell 2001). A recent study demonstrated that females have substantially higher mortality than males (Pace et al. 2017), and as a result, also have substantially shorter life expectancies.

Gestation is approximately one year, after which calves typically nurse for around a year (Kenney 2009; Kraus et al. 2007; Lockyer 1984). After weaning calves, females typically undergo a 'resting' year before becoming pregnant again, presumably because they need time to recover from the energy deficit experienced during lactation (Fortune et al. 2013; Fortune et al. 2012; Pettis et al. 2017b). From 1983 to 2005, annual average calving intervals ranged from three to 5.8 years (overall average of 4.23 years) (Knowlton et al. 1994; Kraus et al. 2007). Between 2006 and 2015, annual average calving intervals continued to vary within this range, but in 2016 and 2017 longer calving intervals were reported (6.3 to 6.6 years in 2016 and 10.2 years in 2017; Hayes et al. 2018a; Pettis and Hamilton 2015; Pettis and Hamilton 2016; Pettis et al. 2017a; Surrey-Marsden et al. 2017). Females have been known to give birth as young as five years old, but the mean age of first partition is about 10 years old (Kraus et al. 2007).

Pregnant North Atlantic right whales migrate south, through the mid-Atlantic region of the United States, to low latitudes during late fall where they overwinter and give birth in shallow, coastal waters (Kenney 2009; Krzystan et al. 2018). During spring, these females migrate back north with their new calves to high latitude foraging grounds where they feed on large concentrations of copepods, primarily *Calanus finmarchicus* (Mayo et al. 2018; NMFS 2017h). Some non-reproductive North Atlantic right whales (males, juveniles, non-reproducing females) also migrate south along the mid-Atlantic region, although at more variable times throughout the winter, while others appear to not migrate south, and instead remain in the northern feeding grounds year round or go elsewhere (Bort et al. 2015; Mayo et al. 2018; Morano et al. 2012; NMFS 2017h; Stone et al. 2017b). Nonetheless, calving females arrive to the southern calving grounds earlier and stay in the area more than twice as long as other demographics (Krzystan et al. 2018). Little is known about North Atlantic right whale habitat use in the mid-Atlantic, but recent acoustic data indicate near year round presence of at least some whales off the coasts of New Jersey, Virginia, and North Carolina (Davis et al. 2017; Hodge et al. 2015; Salisbury et al. 2016; Whitt et al. 2013). While it is generally not known where North Atlantic right whales mate, some evidence suggests that mating may occur in the northern feeding grounds (Cole et al. 2013; Matthews et al. 2014).

7.2.3.2 Population dynamics

The following is a discussion of the species' population and its variance over time. This section includes a discussion of abundance, population growth rate and vital rates, genetic diversity, and spatial distribution as it relates to the North Atlantic right whale.

There are currently two recognized populations of North Atlantic right whales, an eastern and a western population. In the eastern North Atlantic, sightings of right whales are rare and the population may be functionally extinct (Best et al. 2001). In the western North Atlantic, there were estimated to be 458 in November 2015 based on a Bayesian mark–recapture open population model, which accounts for individual differences in the probability of being photographed (95 percent credible intervals 444–471, Pace et al. 2017). While photographic data for 2016 are still being processed, using this same Bayesian methodology with the available data as of September 1, 2017, gave an estimate of 451 individuals for 2016 (Pettis et al. 2017a). Accurate pre-exploitation abundance estimates are not available for either population of the species. The western population may have numbered fewer than 100 individuals by 1935, when international protection for right whales came into effect (Kenney et al. 1995).

The western North Atlantic population demonstrated overall growth of 2.8 percent per year between 1990 to 2010, despite a decline in 1993 and no growth between 1997 and 2000 (Pace et al. 2017). However, since 2010 the population has been in decline, with a 99.99 percent probability of a decline of just under one percent per year (Pace et al. 2017). Between 1990 and 2015, survival rates appeared to be relatively stable, but differed between the sexes, with males having higher survivorship than females (males: 0.985 ± 0.0038; females: 0.968 + 0.0073) leading to a male-biased sex ratio (approximately 1.46 males per female, Pace et al. 2017). During this same period, calving rates varied substantially, with low calving rates coinciding with all three periods of decline or no growth (Pace et al. 2017). On average, North Atlantic right whale calving rates are estimated to be roughly half that of southern right whales (*Eubalaena australis*) (Pace et al. 2017), which are increasing in abundance (NMFS 2015d).

While data are not yet available to statistically estimate the population's trend beyond 2015, three lines of evidence indicate the population is still in decline. First, calving rates in recent years were low. Only five new calves were documented in 2017 (Pettis et al. 2017a), well below the number needed to compensate for expected mortalities (Pace et al. 2017), and for 2018, no new calves were reported (Zoodsma personal communication to E. Patterson on February 26, 2018). Long-term photographic identification data indicate new calves rarely go undetected, so these years likely represent a continuation of the low calving rates that began in 2012 (Kraus et al. 2007; Pace et al. 2017). Second, as noted above, the preliminary abundance estimate for 2016 is 451 individuals, down approximately 1.5 percent from 458 in 2015. Third, since June 2017, at least 19 North Atlantic right whales have died in what has been declared an Unusual Mortality Event[15] (UME), and at least one calf died prior to this in April 2017 (Meyer-Gutbrod et al. 2018; NMFS 2017h). Twelve whales died in Canada in the Gulf of St. Lawrence area, seven off the New England coast of the United States, and one off the coast of the Virginia-North Carolina border. To date, four mortalities have been attributed to entanglement in fishing gear and five showed signs of blunt force trauma consistent with vessel strikes (Daoust et al. 2017; Hardy personal communication to D. Fauquier on October 5, 2017; Meyer-Gutbrod et al. 2018; Pettis et al. 2017a). The remaining causes of death could not be, or have yet to be, determined.

Analysis of mtDNA from North Atlantic right whales has identified seven mtDNA haplotypes in the western North Atlantic (Malik et al. 1999; McLeod and White 2010). This is significantly

[15] https://www.fisheries.noaa.gov/national/marine-life-distress/2017-2018-north-atlantic-right-whale-unusual-mortality-event

less diverse than southern right whales and may indicate inbreeding (Hayes et al. 2018b; Malik et al. 2000; Schaeff et al. 1997). While analysis of historic DNA taken from museum specimens indicates that the eastern and western populations were likely not genetically distinct, the lack of recovery of the eastern North Atlantic population indicates at least some level of population segregation (Rosenbaum et al. 1997; Rosenbaum et al. 2000). Overall, the species has low genetic diversity as would be expected based on its low abundance. However, analysis of 16th and 17th century whaling bones indicate this low genetic diversity may pre-date whaling activities (McLeod et al. 2010). Despite this, Frasier et al. (2013) recently identified a post-copulatory mechanism that appears to be slowly increasing genetic diversity among right whale calves.

Today, North Atlantic right whales are primarily found in the western North Atlantic, from their calving grounds in lower latitudes off the coast of the southeastern United States to their feeding grounds in higher latitudes off the coast of New England and Nova Scotia (Hayes et al. 2018b). In recent years, there has been a shift in distribution in their feeding grounds, with fewer animals being seen in the Great South Channel and the Bay of Fundy and more animals being observed in the Gulf of Saint Lawrence and mid-Atlantic region (Daoust et al. 2017; Davis et al. 2017; Hayes et al. 2018a; Hayes et al. 2018b; Meyer-Gutbrod et al. 2018; Pace et al. 2017). Very few individuals likely make up the population in the eastern Atlantic, which is thought to be functionally extinct (Best et al. 2001). However, in recent years, a few known individuals from the western population have been seen in the eastern Atlantic, suggesting some individuals may have wider ranges than previously thought (Kenney 2009).

7.2.3.3 Vocalization and Hearing

North Atlantic right whales vocalize during social interaction and likely to communicate over long distances (McCordic et al. 2016; Parks and Clark 2007; Parks et al. 2011b; Tyson et al. 2007). Calls among North Atlantic right whales are similar to those of other right whale species, and can be classified into six major call types: screams, gunshots, blows, upcalls, warbles, and downcalls (McDonald and Moore 2002; Parks et al. 2011b; Parks and Tyack 2005; Soldevilla et al. 2014). The majority of vocalizations occur in the 200 Hz to one kHz range with most energy being below one kHz, but there is large variation in frequency depending on the call type (Hatch et al. 2012; Parks and Tyack 2005; Trygonis et al. 2013; Vanderlaan et al. 2003). Source levels range from 137 to 192 dB re: 1 µPa at 1 m (rms), with gunshot calls having higher source levels as compared to other call types (Hatch et al. 2012; Parks and Tyack 2005; Trygonis et al. 2013). Some of these levels are low compared to some other baleen whales, which may put North Atlantic right whales at greater risk of communication masking compared to other species (Clark et al. 2009; Hatch et al. 2012). However, recent evidenced suggests that gunshot calls with their higher source levels may be less susceptible to masking compared to other baleen whale sounds (Cholewiak et al. 2018). Individual calls typically have a duration of 0.04 to 1.5 seconds depending on the call type, and bouts of calls can last for several hours (Parks et al. 2012a; Parks and Tyack 2005; Trygonis et al. 2013; Vanderlaan et al. 2003).

Vocalizations vary by demographic and context. Upcalls are perhaps the most ubiquitous call type, being commonly produced by all age and sex classes (Parks et al. 2011b). Other non-stereotyped tonal calls (e.g., screams) are also produced by all age sex classes (Parks et al. 2011b) but have been primarily attributed to adult females (Parks and Tyack 2005). Warbles are thought to be produced by calves and may represent 'practice' screams (Parks and Clark 2007; Parks and Tyack 2005). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Gunshots appear to be largely or exclusively male vocalizations and may be a form of vocal display (Parks and Clark 2007; Parks et al. 2005; Parks et al. 2011b). Downcalls have been less frequently recorded, and while it is not known if they are produced by specific age-sex classes, they have been recorded in various demographic make ups of surface-active groups (Parks and Tyack 2005). A recent study examining the development of calls in North Atlantic right while found age-related changes in call production continue into adulthood (Root-Gutteridge et al. 2018).

All types of right whale calls have been recorded in surface-active groups, with smaller groups vocalizing more than larger groups and vocalization being more frequent in the evening, at night, and perhaps on the calving grounds (Matthews et al. 2001; Matthews et al. 2014; Morano et al. 2012; Parks and Clark 2007; Parks et al. 2012a; Salisbury et al. 2016; Soldevilla et al. 2014; Trygonis et al. 2013). Screams are usually produced within 10 m of the surface (Matthews et al. 2001). Upcalls have been detected nearly year-round in Massachusetts Bay, peaking in April (Mussoline et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of upcall and gunshot vocalizations from November through January possibly associated with mating (Bort et al. 2015; Matthews et al. 2014; Morano et al. 2012; Mussoline et al. 2012). Upcalls may be used for long distance communication (McCordic et al. 2016), including to reunite calves with mothers (Parks and Clark 2007; Tennessen and Parks 2016). In fact, a recent study indicates they contain information on individual identity and age (McCordic et al. 2016). However, while upcalls are frequently heard on the calving grounds (Soldevilla et al. 2014), they are infrequently produced by mothers and calves here perhaps because the two maintain visual contact until calves are approximately three to four months of age (Parks and Clark 2007; Parks and Van Parijs 2015; Trygonis et al. 2013). North Atlantic right whales shift calling frequencies, particularly those of upcalls, and increase call amplitude over both long and short term periods due to exposure to vessel sound, which may limit their communication space by as much as 67 percent compared to historically lower sound conditions (Hatch et al. 2012; Parks and Clark 2007; Parks et al. 2007a; Parks et al. 2011a; Parks et al. 2012b; Parks et al. 2009; Tennessen and Parks 2016).

There are no direct data on the hearing range of North Atlantic right whales, although they are considered to be part of the low frequency hearing group with a hearing range between 7 Hz and

35 kHz (NOAA 2018). However, based on anatomical modeling, their hearing range is predicted to be from 10 Hz to 22 kHz with a functional range probably between 15 Hz to 18 kHz (Parks et al. 2007b).

7.2.3.4 Status

The North Atlantic right whale is listed under the ESA as endangered. Currently, none of its recovery goals (see Section 7.2.3.6 below) have been met (NMFS 2017h). With whaling now prohibited, the two major known human causes of mortality are vessel strikes and entanglement in fishing gear (Hayes et al. 2018a). Progress has been made in mitigating vessel strikes by regulating vessel speeds (78 FR 73726) (Conn and Silber 2013), but entanglement in fishing gear remains a major threat (Kraus et al. 2016), which appears to be worsening (Hayes et al. 2018a). From 1990 to 2010, the population experienced overall growth consistent with one of its recovery goals (see Section 7.2.3.6 below). However, the population is currently experiencing a UME that appears to be related to both vessel strikes and entanglement in fishing gear (Daoust et al. 2017). On top of this, recent modeling efforts indicate that low female survival, a male biased sex ratio, and low calving success are contributing to the population's current decline (Pace et al. 2017). While there are likely a multitude of factors involved, low calving has been linked to poor female health (Rolland et al. 2016) and reduced prey availability (Devine et al. 2017; Johnson et al. 2017; Meyer-Gutbrod and Greene 2014; Meyer-Gutbrod and Greene 2018; Meyer-Gutbrod et al. 2018). Furthermore, entanglement in fishing gear appears to have substantial health and energetic costs that affect both survival and reproduction (Hayes et al. 2018a; Hunt et al. 2018; Lysiak et al. 2018; Pettis et al. 2017b; Robbins et al. 2015; Rolland et al. 2017; van der Hoop et al. 2017). In fact, there is evidence of a population wide decline in health since the early 1990s, the last time the population experienced a population decline (Rolland et al. 2016). Given this status, the species resilience to future perturbations is considered very low (Hayes et al. 2018a). Using a matrix population projection model, Hayes et al. (2018a) estimates that by 2029 the population will to decline to the 1990 estimate of 123 females if the current rate of decline is not altered. Consistent with this, recent modelling efforts by Meyer-Gutbrod and Greene (2018) indicate that that the species may decline towards extinction if prey conditions worsen, as predicted under future climate scenarios (Grieve et al. 2017), and anthropogenic mortalities are not reduced (Meyer-Gutbrod et al. 2018). In fact, recent data from the Gulf of Maine and Gulf of St. Lawrence indicate prey densities may already be in decline (Devine et al. 2017; Johnson et al. 2017; Meyer-Gutbrod et al. 2018).

7.2.3.5 Critical Habitat

Critical habitat for right whales in the North Atlantic was designated in 1994 and expanded in 2016. Presently, North Atlantic designated critical habitat includes two major units: Unit 1 located in the Gulf of Maine and Georges Bank Region and Unit 2 located off the coast of North Carolina, South Carolina, Georgia, and Florida (Figure 24). Unit 1 consists of important foraging area and contains the following physical and biological features essential to the conservation of the species: the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the zooplankton species *C. finmarchicus* for right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes; low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and diapausing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region. Unit 2 consists of an important calving area and contains the following physical and biological features essential to the conservation of the species: sea surface conditions associated with Force four or less on the Beaufort Scale, sea surface temperatures of 7 to 17 °Celsius, and water depths of six to 28 m, where these features simultaneously co-occur over contiguous areas of at least 231 nautical square-miles of ocean waters during the months of November through April. Only Unit 2 is within the action area. However, as noted in Section 7.1.4, the proposed action will have no effect on designated North Atlantic right whale critical habitat.

7.2.3.6 Recovery Goals

See the 2005 updated Recovery Plan for the North Atlantic right whale for complete down listing criteria for the following recovery goals:

1. The population ecology (range, distribution, age structure, and gender ratios, etc.) and vital rates (age-specific survival, age-specific reproduction, and lifetime reproductive success) of right whales are indicative of an increasing population;
2. The population has increased for a period of thirty-five years at an average rate of increase equal to or greater than two percent per year;
3. None of the known threats to Northern right whales are known to limit the population’s growth rate; and
4. Given current and projected threats and environmental conditions, the right whale population has no more than a one percent chance of quasi-extinction in one hundred years.

7.2.4 Sei Whale

The sei whale is a widely distributed baleen whale found in all major oceans (Figure 25).

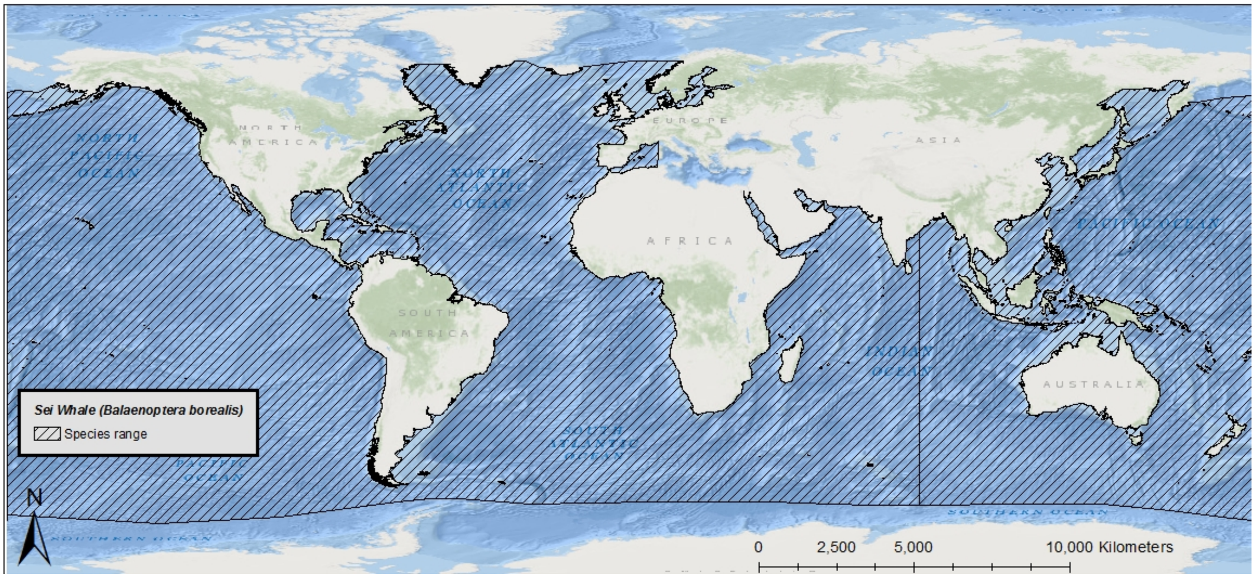

Figure 25. Map identifying the range of the endangered sei whale.

Sei whales are distinguishable from other whales by a long, sleek body that is dark bluish-gray to black in color and pale underneath, and a single ridge located on their rostrum. The sei whale was originally listed as endangered on December 2, 1970 (Table 3).

Information available from the recovery plan (NMFS 2011c), recent stock assessment reports (Carretta et al. 2018; Hayes et al. 2018b; Muto et al. 2018), and status review (NMFS 2012b) were used to summarize the life history, population dynamics and status of the species as follows.

7.2.4.1 Life History

Sei whales can live, on average, between 50 and 70 years. They have a gestation period of 10 to 12 months, and calves nurse for six to nine months. Sexual maturity is reached between six and 12 years of age with an average calving interval of two to three years. Sei whales mostly inhabit continental shelf and slope waters far from the coastline. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed on a range of prey types, including: plankton (copepods and krill), small schooling fishes, and cephalopods.

7.2.4.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the sei whale.

Two sub-species of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. There are no estimates of pre-exploitation abundance for the North Atlantic Ocean. Models indicate that total abundance declined from 42,000 to 8,600 individuals between 1963 and 1974 in the North Pacific Ocean. More recently, the North

Pacific Ocean population was estimated to be 29,632 (95 percent confidence intervals 18,576 to 47,267) between 2010 and 2012 (IWC 2016; Thomas et al. 2016). In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 whales, with recent abundance estimated at 9,800 to 12,000 whales. Three relatively small stocks occur in U.S. waters: Nova Scotia (N=357, N_{min}=236), Hawaii (N=391, N_{min}=204), and Eastern North Pacific (N=519, N_{min}=374). Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales.

Based on genetic analyses, there appears to be some differentiation between sei whale populations in different ocean basins. An early study of allozyme variation at 45 loci found some genetic differences between Southern Ocean and the North Pacific sei whales (Wada and Numachi 1991). However, more recent analyses of mtDNA control region variation show no significant differentiation between Southern Ocean and the North Pacific sei whales, though both appear to be genetically distinct from sei whales in the North Atlantic (Baker and Clapham 2004; Huijser et al. 2018). Within ocean basin, there appears to be intermediate to high genetic diversity and little genetic differentiation despite there being different managed stocks (Danielsdottir et al. 1991; Huijser et al. 2018; Kanda et al. 2011; Kanda et al. 2006; Kanda et al. 2015; Kanda et al. 2013).

Sei whales are distributed worldwide, occurring in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere.

7.2.4.3 Vocalizations and Hearing

Data on sei whale vocal behavior is limited, but includes records off the Antarctic Peninsula of broadband sounds in the 100-600 Hz range with 1.5 second duration and tonal and upsweep calls in the 200 to 600 Hz range of one to three second durations (McDonald et al. 2005). Vocalizations from the North Atlantic consisted of paired sequences (0.5-0.8 seconds, separated by 0.4 to 1.0 seconds) of 10 to 20 short (4 milliseconds) frequency modulated sweeps between 1.5 to 3.5 kHz (Thomson and Richardson 1995). Source levels of 189 ±5.8 dB re: 1 µPa at 1 m have been established for sei whales in the northeastern Pacific Ocean (Weirathmueller et al. 2013).

Direct studies of sei whale hearing have not been conducted, but it is assumed that they can hear the same frequencies that they produce (low) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995). This suggests sei whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997). In terms of functional hearing capability, sei whales belong to the low-frequency group, which have a hearing range of 7 Hz to 35 kHz (NOAA 2018).

7.2.4.4 Status

The sei whale is endangered as a result of past commercial whaling. Now, only a few individuals are taken each year by Japan; however, Iceland has expressed an interest in targeting sei whales. Current threats include vessel strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and anthropogenic sound. Given the species' overall abundance, they may be somewhat resilient to current threats. However, trends are largely unknown, especially for individual stocks, many of which have relatively low abundance estimates.

7.2.4.5 Critical Habitat

No critical habitat has been designated for the sei whale.

7.2.4.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover sei whale populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2011 Final Recovery Plan for the sei whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable populations in all ocean basins.
2. Ensure significant threats are addressed.

7.2.5 Sperm Whales

The sperm whale is widely distributed and found in all major oceans (Figure 26).

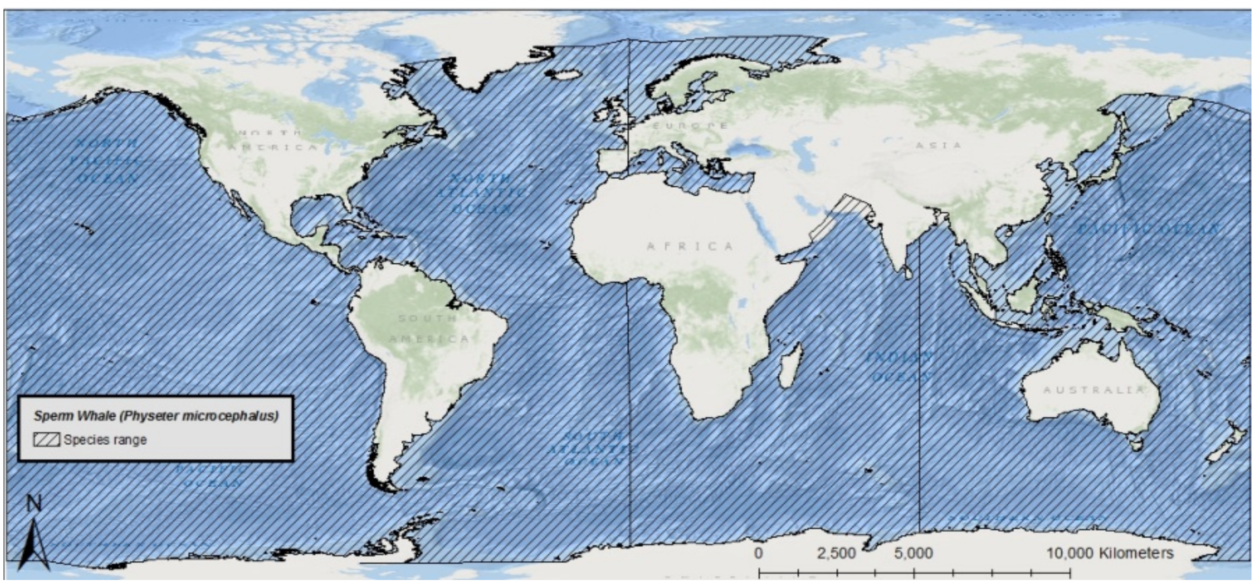

Figure 26. Map identifying the range of the endangered sperm whale.

The sperm whale is the largest toothed whale and distinguishable from other whales by its extremely large head, which takes up 25 to 35 percent of its total body length, and a single blowhole asymmetrically situated on the left side of the head near the tip. The sperm whale was originally listed as endangered on December 2, 1970 (Table 3).

Information available from the recovery plan (NMFS 2010b), recent stock assessment reports (Carretta et al. 2018; Hayes et al. 2018b; Muto et al. 2018), and status review (NMFS 2015e) were used to summarize the life history, population dynamics and status of the species as follows.

7.2.5.1 Life History

The average lifespan of sperm whales is estimated to be at least 50 years (Whitehead 2009). They have a gestation period of one to one and a half years, and calves nurse for approximately two years, though they may begin to forage for themselves within the first year of life (Tønnesen et al. 2018). Sexual maturity is reached between seven and 13 years of age for females with an average calving interval of four to six years. Male sperm whales reach full sexual maturity in their 20s. Sperm whales mostly inhabit areas with a water depth of 600 m or more, and are uncommon in waters less than 300 m deep. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed primarily on squid; other prey includes octopus and demersal fish (including teleosts and elasmobranchs).

7.2.5.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the sperm whale.

The sperm whale is the most abundant of the large whale species, with total abundance estimates between 200,000 and 1,500,000. The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA listing. There are no reliable estimates for sperm whale abundance across the entire Atlantic Ocean. However, estimates are available for two of three U.S. stocks in the Atlantic Ocean, the Northern Gulf of Mexico stock, estimated to consist of 763 individuals (N_{min}=560) and the North Atlantic stock, underestimated to consist of 2,288 individuals (N_{min}=1,815). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 (95 percent confidence intervals 14,800 to 34,600) in 1993. Population estimates are also available for two of three U.S. stocks that occur in the Pacific, the California/Oregon/ Washington stock, estimated to consist of 2,106 individuals (N_{min}=1,332), and the Hawaii stock, estimated to consist of 4,559 individuals (N_{min}=3,478). There are insufficient data to estimate the population abundance of the North Pacific stock. We are aware of no reliable abundance estimates specifically for sperm whales in the South Pacific Ocean, and there is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time.

Ocean-wide genetic studies indicate sperm whales have low genetic diversity, suggesting a recent bottleneck, but strong differentiation between matrilineally related groups (Lyrholm and Gyllensten 1998). Consistent with this, two studies of sperm whales in the Pacific Ocean indicate low genetic diversity (Mesnick et al. 2011; Rendell et al. 2012). Furthermore, sperm whales from the Gulf of Mexico, the western North Atlantic Ocean, the North Sea, and the Mediterranean Sea all have been shown to have low levels of genetic diversity (Engelhaupt et al. 2009). As none of the stocks for which data are available have high levels of genetic diversity, the species may be at some risk to inbreeding and 'Allee' effects, although the extent to which is currently unknown. Sperm whales have a global distribution and can be found in relatively deep waters in all ocean basins. While both males and females can be found in latitudes less than 40°, only adult males venture into the higher latitudes near the poles.

7.2.5.3 Vocalizations and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 Hz to greater than 30 kHz (Watkins 1977) and dominant frequencies between 1 to 6 kHz and 10 to 16 kHz. Another class of sound, "squeals," are produced with frequencies of 100 Hz to 20 kHz (e.g., Weir et al. 2007). The source levels of clicks can reach 236 dB re: 1 µPa at 1 m, although lower source level energy has been suggested at around 171 dB re: 1 µPa at 1 m (Goold and Jones 1995; Mohl et al. 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997). Most of the energy in sperm whale clicks is concentrated at around 2 to 4 kHz and 10 to 16 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140 to 162 dB re: 1 µPa at 1 m (Madsen et al. 2003). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Norris and Harvey 1972).

Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Miller et al. 2004; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997; Whitehead and Weilgart 1991). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005; Miller et al. 2004). Clicks are also used during social behavior and intragroup interactions (Weilgart and Whitehead 1993). When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004; Weilgart and Whitehead 1997). Research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects (Pavan et al. 2000; Weilgart and Whitehead 1997). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas are associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Our understanding of sperm whale hearing stems largely from the sounds they produce. The only direct measurement of hearing was from a young stranded individual from which auditory evoked potentials were recorded (Carder and Ridgway 1990). From this whale, responses support a hearing range of 2.5 to 60 kHz and highest sensitivity to frequencies between 5 to 20 kHz. Other hearing information consists of indirect data. For example, the anatomy of the sperm whale's inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992). The sperm whale may also possess better low-frequency hearing than other odontocetes, although not as low as many baleen whales (Ketten 1992). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985; Watkins and Schevill 1975). In the Caribbean Sea, Watkins et al. (1985) observed that sperm whales exposed to 3.25 to 8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial sound generated by banging on a boat hull (Watkins et al. 1985). André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signal did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). Aaron et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel's propeller (110 dB re: 1 μPa^2-s between 250 Hz and one kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. Sperm whales have also been observed to stop vocalizing for brief periods when codas are being produced by other individuals, perhaps because they can hear better when not vocalizing themselves (Goold and Jones 1995). Because they spend large amounts of time at depth and use low frequency sound, sperm whales are likely to be susceptible to low frequency sound in the ocean (Croll et al. 1999). Nonetheless, sperm whales are considered to be part of the mid-frequency marine mammal hearing group, with a hearing range between 150 Hz and 160 kHz (NOAA 2018).

7.2.5.4 Status

The sperm whale is endangered as a result of past commercial whaling. Although the aggregate abundance worldwide is probably at least several hundred thousand individuals, the extent of depletion and degree of recovery of populations are uncertain. Commercial whaling is no longer allowed, however, illegal hunting may occur. Continued threats to sperm whale populations include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, population, loss of prey and habitat due to climate change, and sound. The species' large population size shows that it is somewhat resilient to current threats.

7.2.5.5 Critical Habitat

No critical habitat has been designated for the sperm whale.

7.2.5.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover sperm whale populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2010 Final Recovery Plan for the sperm whale for complete downlisting/delisting criteria for both of the following recovery goals.

1. Achieve sufficient and viable populations in all ocean basins.
2. Ensure significant threats are addressed.

7.2.6 Green Sea Turtle (North Atlantic Distinct Population Segment)

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters. The North Atlantic DPS of green turtle is found in the North Atlantic Ocean and Gulf of Mexico (Figure 27).

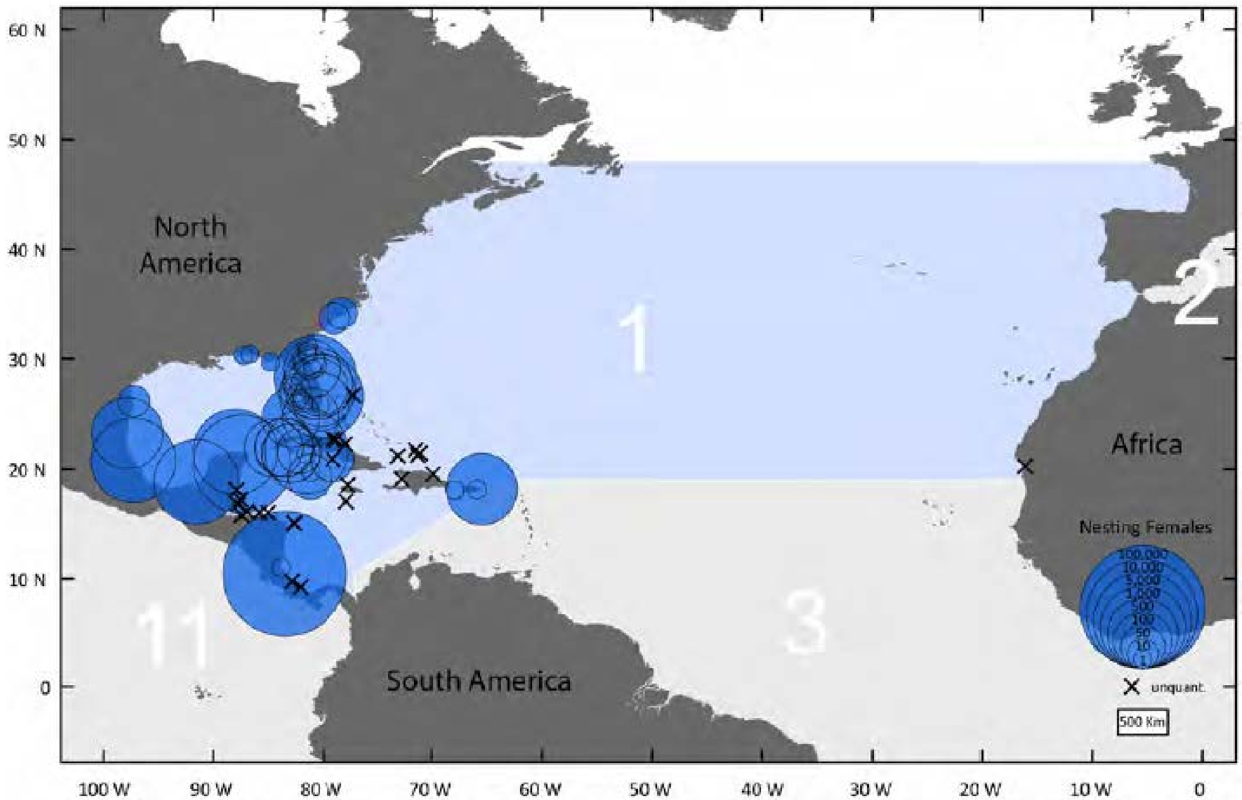

Figure 27. Geographic range of the North Atlantic distinct population segment of green turtles, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kilograms (kg) and a straight carapace length of greater than one meter. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two ESA-listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed 11 DPSs of green turtles as threatened or endangered under the ESA (Table 3). The North Atlantic DPS of green turtle is ESA-listed as threatened.

We used information available in the 2007 Five Year Review (NMFS and USFWS 2007a) and 2015 Status Review (Seminoff et al. 2015) to summarize the life history, population dynamics, and status of the species as follows.

7.2.6.1 Life History

Age at first reproduction for females is 20 to 40 years. Green turtles lay an average of three nests per season with an average of 100 eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation, and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult sea turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges, and other invertebrate prey.

7.2.6.2 Population Dynamics

The following discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the North Atlantic DPS of green turtle.

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Figure 27), and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79 percent of nesting females for the DPS (Seminoff et al. 2015).

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS. For the North Atlantic DPS of green turtle, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets for 25 years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9 percent, and the Tortuguero, Costa Rica, population growing at 4.9 percent.

The North Atlantic DPS of green turtle has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting sub-populations in Florida, Cuba, Mexico, and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5° North, 77° West) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48° North, 77° West) in the north. The range of the North Atlantic DPS then extends due east along latitudes 48° North and 19° North to the western coasts of

Europe and Africa (Figure 27). Nesting occurs primarily in Costa Rica, Mexico, Florida, and Cuba.

7.2.6.3 Vocalization and Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 to 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969). Piniak et al. (2016) found green turtle juveniles capable of hearing underwater sounds at frequencies of 50 Hz to 1,600 Hz (maximum sensitivity at 200 to 400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Other studies have similarly found greatest sensitivities between 200 to 400 Hz for the green turtle with a range of 100 to 500 Hz (Bartol and Ketten 2006; Ridgway et al. 1969).

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

7.2.6.4 Status

Once abundant in tropical and sub-tropical waters, green turtles worldwide exist at a fraction of their historical abundance as a result of over-exploitation. Globally, egg harvest, the harvest of females on nesting beaches and directed hunting of sea turtles in foraging areas remain the three greatest threats to their recovery. In addition, bycatch in drift-net, long-line, set-net, pound-net, and trawl fisheries kill thousands of green turtles annually. Increasing coastal development (including beach erosion and re-nourishment, construction and artificial lighting) threatens nesting success and hatchling survival. On a regional scale, the different DPSs experience these threats as well, to varying degrees. Differing levels of abundance combined with different intensities of threats and effectiveness of regional regulatory mechanisms make each DPS uniquely susceptible to future perturbations.

Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population’s decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green turtle generation, up to 50 years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations.

7.2.6.5 Critical Habitat

On September 2, 1998, NMFS designated critical habitat for green turtles, which include coastal waters surrounding Culebra Island, Puerto Rico. Green turtle critical habitat is not in the action area. Accordingly, we find that the proposed action will have no effect on designated green turtle critical habitat and this habitat will not be considered further in this opinion.

7.2.6.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover green turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 1998 and 1991 recovery plans for the Pacific, East Pacific, and Atlantic populations of green turtles for complete downlisting/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

7.2.7 Kemp’s Sea Ridley Turtle

The Kemp’s ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 28).

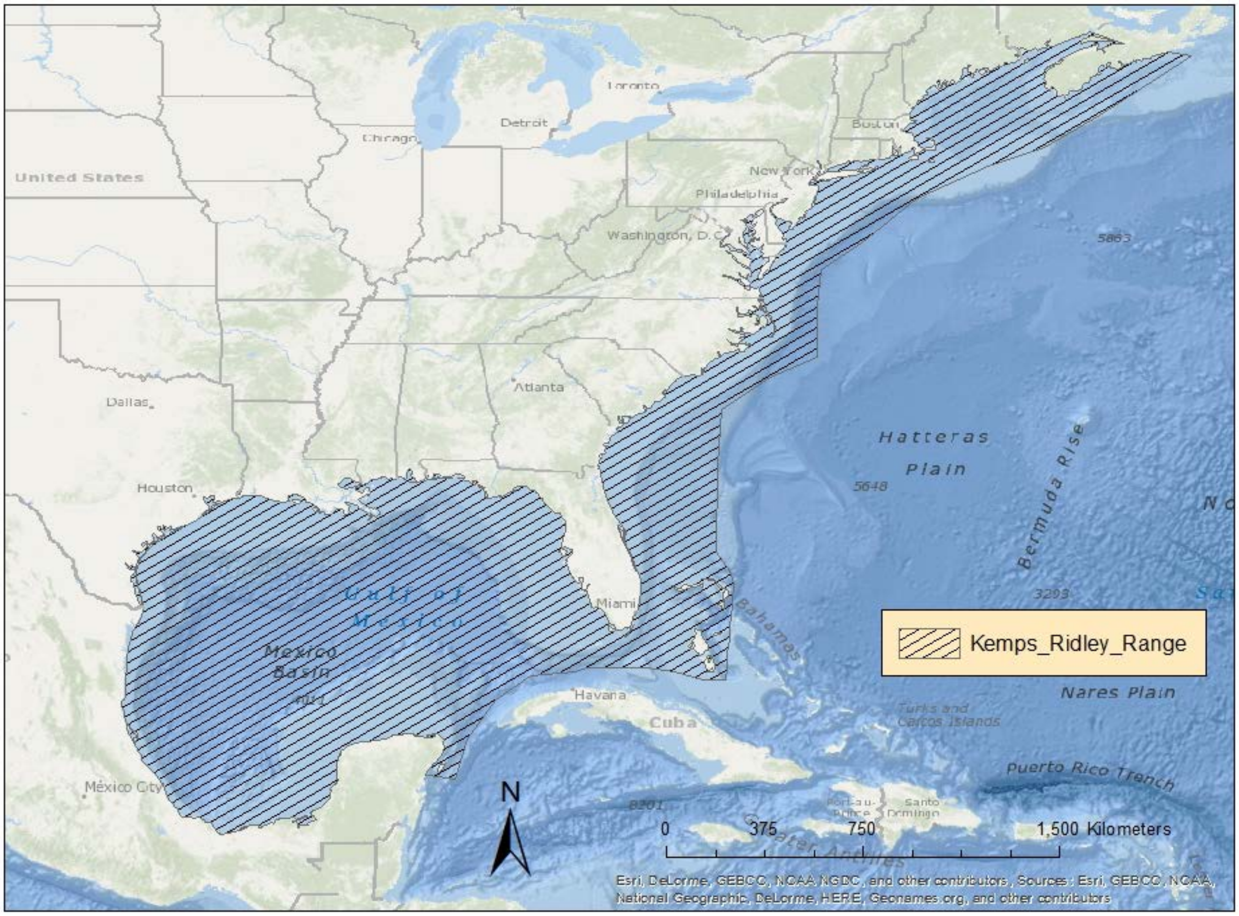

Figure 28. Map identifying the range of the endangered Kemp's ridley turtle.

Kemp's ridley turtles are the smallest of all sea turtle species, with a nearly circular top shell and pale yellowish bottom shell. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973 and listed as endangered under the ESA since 1973 (Table 3).

We used information available in the revised recovery plan (NMFS et al. 2011) and the five-year review (NMFS and USFWS 2015) to summarize the life history, population dynamics, and status of the species, as follows.

7.2.7.1 Life History

Females mature at 12 years of age. The average remigration is two years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is 97 to 100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats. Juvenile Kemp's ridley turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 37 m deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridley turtles forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS et al. 2011).

7.2.7.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distributions as it relates to the Kemp's ridley turtle.

Of the sea turtle species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS and USFWS 2015). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, four in 1995, 50 in 2005, 197 in 2014 (NMFS and USFWS 2015).

From 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue (NMFS and USFWS 2015). In fact, nest counts dropped by more than a third in 2010 and continue to remain below predictions (Caillouet et al. 2018)

Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS et al. 2011). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas showed six distinct haplotypes, with one of these also being found at Rancho Nuevo (Dutton et al. 2006).

The Kemp's ridley turtle occurs from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). Kemp's ridley turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. During spring and summer, juvenile Kemp's ridley turtles occur in the shallow coastal waters of the northern Gulf of Mexico from Texas to north Florida. In the fall, most Kemp's ridley turtles migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many sea turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2011).

7.2.7.3 Vocalization and Hearing

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

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

7.2.7.4 Status

The Kemp's ridley turtle was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a sanctuary. A successful head-start program has resulted in re-establishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of sea turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. It is clear that the species is steadily increasing; however, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

7.2.7.5 Critical Habitat

No critical habitat has been designated for Kemp's ridley turtles.

7.2.7.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover Kemp's ridley turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were identified as priorities to recover Kemp's ridley turtles:

1. Protect and manage nesting and marine habitats.
2. Protect and manage populations on the nesting beaches and in the marine environment.
3. Maintain a stranding network.

4. Manage captive stocks.
5. Sustain education and partnership programs.
6. Maintain, promote awareness of and expand U.S. and Mexican laws.
7. Implement international agreements.
8. Enforce laws.

7.2.8 Leatherback Sea Turtle

The leatherback turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to sub-polar latitudes, worldwide (Figure 29).

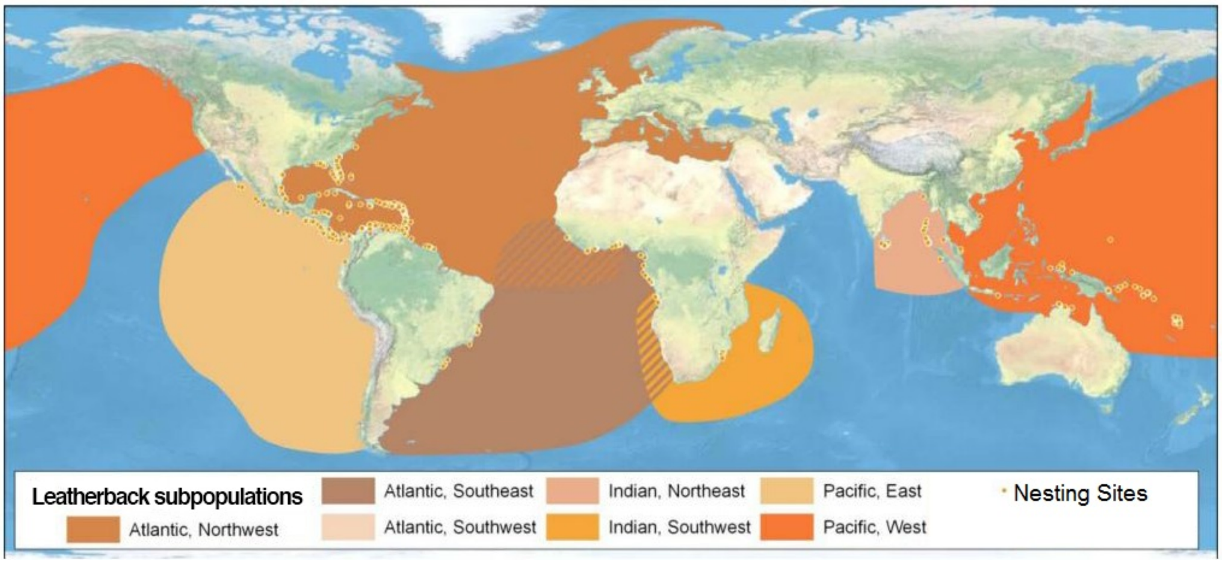

Figure 29. Map identifying the range of endangered leatherback turtle [adapted from Wallace et al. (2013)].

Leatherback turtles are the largest living sea turtle, reaching lengths of 1.8 m long, and weighing up to 907.2 kg. Leatherback turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their belly. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973 (Table 3).

We used information available in the five year review (NMFS and USFWS 2013b) and critical habitat designation to summarize the life history, population dynamics, and status of the species as follows.

7.2.8.1 Life History

Age at maturity has been difficult to ascertain, with estimates ranging from five to 29 years (Avens et al. 2009; Spotila et al. 1996). Females lay up to seven clutches per season, with more than 65 eggs per clutch and eggs weighing greater than 80 grams (Reina et al. 2002; Wallace et al. 2007). The number of leatherback turtle hatchings that make it out of the nest on the beach (i.e., emergent success) is approximately 50 percent worldwide (Eckert et al. 2012). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherback turtles must consume large quantities to support their body weight (Wallace et al. 2018). Leatherback turtles weigh about 33 percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (Aguirre et al. 2006; James et al. 2005). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price et al. 2004).

7.2.8.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the leatherback turtle.

Leatherback turtles are globally distributed, with nesting beaches in the Pacific, Indian, and Atlantic Oceans. Detailed population structure is unknown, but is likely dependent upon nesting beach location. Based on estimates calculated from nest count data, there are between 34,000 and 94,000 adult leatherback turtles in the North Atlantic Ocean (TEWG 2007). In contrast, leatherback turtle populations in the Pacific Ocean are much lower. Overall, Pacific populations have declines from an estimated 81,000 individuals to less than 3,000 total adults and sub-adults (Spotila et al. 2000). Population abundance in the Indian Ocean is difficult to assess due to lack of data and inconsistent reporting. Available data from southern Mozambique show that approximately 10 females nest per year from 1994 through 2004, and about 296 nests per year counted in South Africa (NMFS and USFWS 2013b).

Population growth rates for leatherback turtles vary by ocean basin. Counts of leatherback turtles at nesting beaches in the western Pacific indicate that the sub-population has been declining at a rate of almost six percent per year since 1984 (Tapilatu et al. 2013). Leatherback turtle sub-populations in the Atlantic Ocean, however, are showing signs of improvement. Nesting females in South Africa are increasing at an annual rate of four to 5.6 percent, and from nine to 13 percent in Florida and the U.S. Virgin Islands (TEWG 2007), believed to be a result of conservation efforts.

Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the

Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS and USFWS 2013b).

Leatherback turtles are distributed in oceans throughout the world (Figure 29). Leatherback turtles occur through marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

7.2.8.3 Vocalization and Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969). Dow Piniak (2012) measured hearing of hatchlings leatherback turtles in water and in air, and observed reactions to low frequency sounds, with responses to stimuli occurring between 50 Hz and 1.6 kHz in air and between 50 Hz and 1.2 kHz in water (lowest sensitivity recorded was 93 dB re: 1 µPa at 300 Hz).

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

7.2.8.4 Status

The leatherback turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The primary threats to leatherback turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, and sand extraction. Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea. Plastic ingestion is common in leatherbacks and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex), range (through expansion of foraging habitat), and habitat (through the loss of nesting beaches, because of sea-level rise). The species' resilience to additional perturbation is low.

7.2.8.5 Critical Habitat

On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands. On January 20, 2012, NMFS issued a final rule to designate additional critical habitat for the leatherback turtle along the west coast of the United States. Both critical habitat areas are outside the action area. Accordingly, we find that the proposed action will have no effect on designated leatherback turtle critical habitat and this habitat will not be considered further in this opinion.

7.2.8.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover leatherback turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 1998 and 1991 Recovery Plans for the U.S. Pacific and U.S. Caribbean, Gulf of Mexico, and Atlantic leatherback turtles for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were the top five recovery actions identified to support in the Leatherback Five Year Action Plan:

1. Reduce fisheries interactions.
2. Improve nesting beach protection and increase reproductive output.
3. International cooperation.
4. Monitoring and research.
5. Public engagement.

7.2.9 Loggerhead Sea Turtle (Northwest Atlantic Ocean Distinct Population Segment)

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans. Northwest Atlantic Ocean DPS of loggerhead turtles are found along eastern North America, Central America, and northern South America (Figure 30).

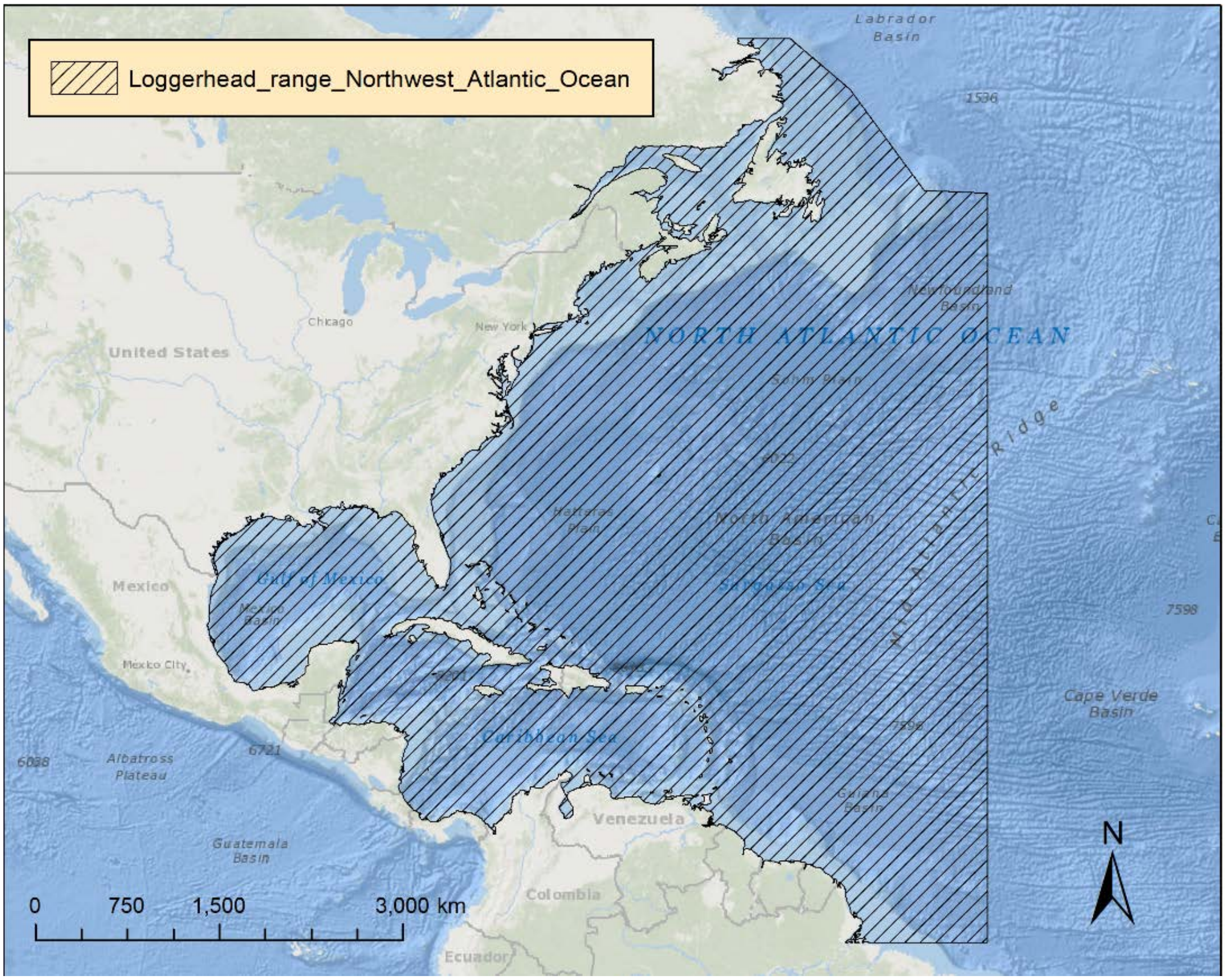

Figure 30. Map identifying the range of the Northwest Atlantic Ocean distinct population segment of loggerhead turtles.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS of loggerhead turtle listed as threatened (Table 3).

We used information available in the 2009 Status Review (Conant et al. 2009) and the final ESA-listing rule to summarize the life history, population dynamics, and status of the species, as follows.

7.2.9.1 Life History

Mean age at first reproduction for female loggerhead turtles is 30 years. Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the sea turtle during the middle of the incubation period. Loggerhead sea turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in the neritic zone (i.e., coastal waters). Coastal waters provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerhead turtles. Neritic juvenile loggerheads forage on crabs, mollusks, jellyfish and vegetation, where as adults typically prey on benthic invertebrates such as mollusks and decapods.

7.2.9.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section includes abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Northwest Atlantic Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560. Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS 2009). In 2010, there were estimated to be approximately 801,000 loggerhead turtles (greater than 30 cm in size, inter-quartile range of approximately 521,000–1,111,000) in northwestern Atlantic continental shelf region based on aerial surveys (NMFS 2011d).

Based on genetic information, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into five recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit. The Northern Recovery Unit, from North Carolina to northeastern Florida, and is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females (NMFS and USFWS 2008). The Peninsular Florida Recovery Unit hosts more than 10,000 females nesting annually, which constitutes 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS of loggerhead turtles (Ehrhart et al. 2003). The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting sub-population on Key West comes from a census conducted from 1995 through 2004 (excluding 2002), which provided a mean of 246 nests per year, or about 60 nesting females (NMFS and USFWS 2007b). The Northern Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year. The Greater Caribbean Recovery Unit encompasses nesting sub-populations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008).

Four of the Northwest Atlantic DPS recovery units have adequate data to examine population trends, the Northern Recovery Unit, the Peninsular Florida Recovery Unit, the Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit, and all appear to be declining (Conant et al. 2009). Nest counts taken at index beaches in Peninsular Florida show a significant decline in loggerhead sea turtle nesting from 1989 through 2006, most likely attributed to mortality of oceanic-stage loggerhead turtles caused by fisheries bycatch (Witherington et al. 2009). Loggerhead turtle nesting on the Archie Carr National Wildlife Refuge (representing individuals of the Peninsular Florida sub-population) has fluctuated over the past few decades. There was an average of 9,300 nests throughout the 1980s, with the number of nests increasing into the 1990s until it reached an all-time high in 1998, with 17,629 nests. From that point, the number of loggerhead turtle nests at the Archie Carr National Wildlife Refuge have declined steeply to a low of 6,405 in 2007, increasing again to 15,539, still a lower number of nests than in 1998 (Bagley et al. 2013). For the Northern Recovery Unit, nest counts at loggerhead turtles nesting beaches in North Carolina, South Carolina, and Georgia declined at 1.9 percent annually from 1983 through 2005 (NMFS and USFWS 2007b). The nesting sub-population in the Florida panhandle has exhibited a significant declining trend from 1995 through 2005 (Conant et al. 2009; NMFS and USFWS 2007b). Recent model estimates predict an overall population decline of 17 percent for the St. Joseph Peninsula, Florida sub-population of the Northern Gulf of Mexico recovery unit (Lamont et al. 2014).

As mentioned previously, genetic analyses were the bases for establishing the five recovery units (Conant et al. 2009). A more recent analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico’s Caribbean Sea coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS should be considered as 10 management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

Loggerhead turtles are circumglobal, occurring throughout the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans, returning to their natal region for mating and nesting. Adults and sub-adults occupy nearshore habitat. While in their oceanic phase, loggerhead turtles undergo long migrations using ocean currents. Individuals from multiple nesting colonies can be found on a single feeding ground. Loggerhead turtles hatchlings from the western Atlantic Ocean disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Mitochondrial DNA evidence demonstrates that juvenile loggerhead turtles from southern Florida nesting beaches comprise the vast majority (71 to 88 percent) of individuals found in foraging grounds throughout the western and eastern Atlantic Ocean: Nicaragua, Panama, Azores and Madeira, Canary Islands and Adalusia, Gulf of Mexico, and Brazil (Masuda 2010).

7.2.9.3 Vocalization and Hearing

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 μPa and two-year olds: about 86 dB re: 1 μPa), with threshold increasing rapidly above and below that frequency (Bartol and Ketten 2006). Underwater tones elicited behavioral responses to frequencies between 50 and 800 Hz and auditory evoked potential responses between 100 and 1,131 Hz in one adult loggerhead turtle (Martin et al. 2012). The lowest threshold recorded in this study was 98 dB re: 1 μPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

7.2.9.4 Status

Due to declines in nest counts at index beaches in the U.S. and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS of loggerhead turtle is at risk and likely to decline in the foreseeable future (Conant et al. 2009).

7.2.9.5 Critical Habitat

On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtles along the U.S. Atlantic and Gulf of Mexico coasts from North Carolina to Mississippi (79 FR 39856) (Figure 31). These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. The critical habitat is categorized into 38 occupied marine areas and 1,102.4 km (685 miles) of nesting beaches. The PBFs identified for the different habitat types include waters adjacent to high density nesting beaches, waters with minimal obstructions and manmade structures, high densities of reproductive males and females, appropriate passage conditions for migration, conditions that support *Sargassum* habitat, available prey, and sufficient water depth and proximity to currents to ensure offshore transport of post-hatchlings.

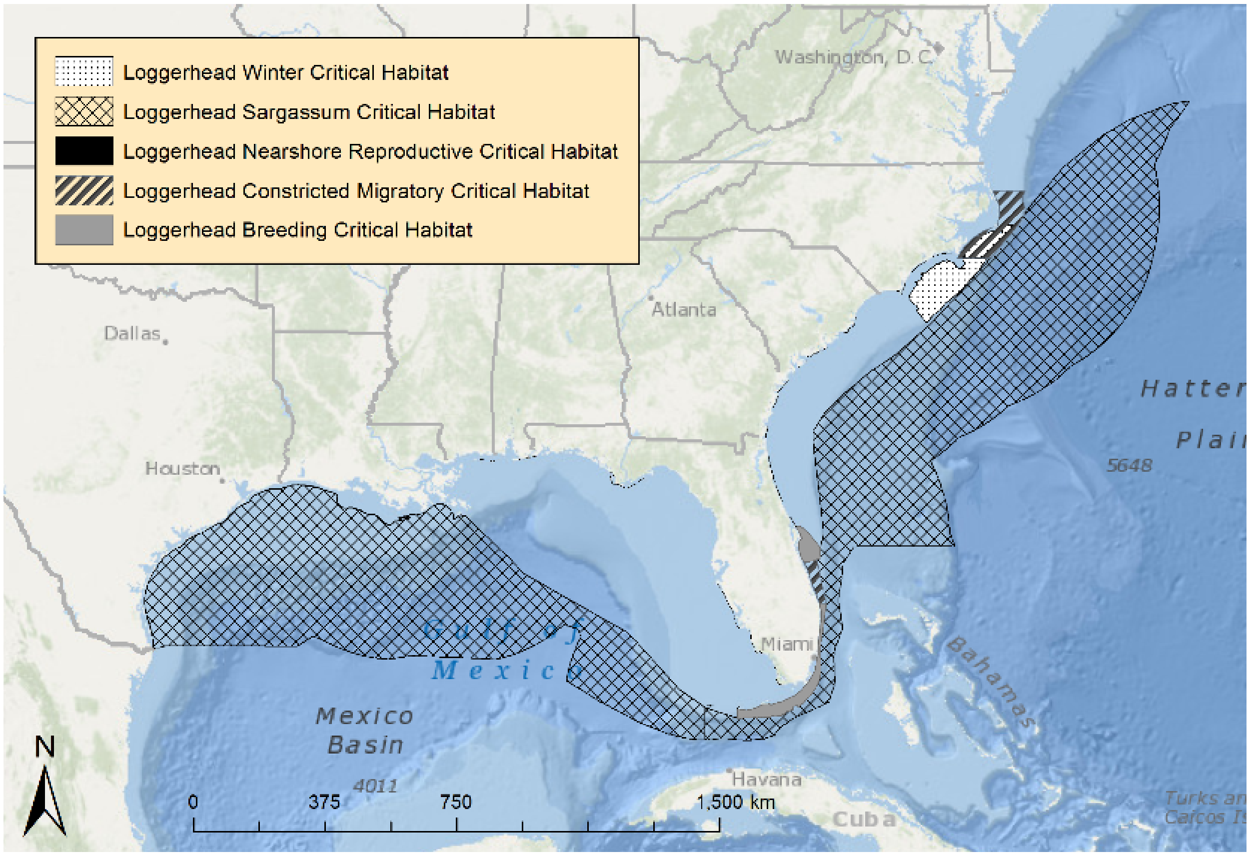

Figure 31. Map identifying designated critical habitat for the Northwest Atlantic Ocean distinct population segment of loggerhead turtle.

Although the proposed action may occur in units of designated loggerhead critical habitat, as discussed in Section 7.1.5, the proposed action will either have no affect or is not likely to adversely affect the various units of designated loggerhead critical habitat. As a result, designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead sea turtles is not considered further in this opinion.

7.2.9.6 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations. These threats will be discussed in further detail in the environmental baseline section of this opinion. See the 2009 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads for complete downlisting/delisting criteria for each of the following recovery objectives:

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
3. Manage sufficient nesting beach habitat to ensure successfully nesting.

4. Manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction.
5. Eliminate legal harvest.
6. Implement scientifically based nest management plans.
7. Minimize nest predation.
8. Recognize and respond to mass/unusual mortality or disease event appropriately.
9. Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerhead turtles and their terrestrial and marine habitats.
10. Minimize bycatch in domestic and international commercial and artisanal fisheries.
11. Minimize trophic changes from fishery harvest and habitat alteration.
12. Minimize marine debris ingestions and entanglement.
13. Minimize vessel strike mortality.

8 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 which are contemporaneous with the consultation in process (50 C.F.R. §402.02).

ESA-listed whales and sea turtles have been affected by many of the same impacts (e.g., climate change, habitat degradation, fisheries interactions, etc.), but owing to differences in the species' life history and habitat use, these impacts may affect the species differently. To illustrate the impacts of the environmental baseline on the species considered in this opinion, we have grouped the baselines for ESA-listed whales and sea turtles.

8.1 Climate Change

The 2014 Assessment Synthesis Report from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) concluded climate change is unequivocal (IPCC 2014). The report concludes oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m have warmed by 0.11° C per decade over the period 1971 through 2010) (IPCC 2014). Global mean sea level rose by 0.19 m between 1901 and 2010, and the rate of sea-level rise since the mid-19th century has been greater than the mean rate during the previous two millennia (IPCC 2014). The Atlantic Ocean appears to be warming faster than all other ocean basins except perhaps the southern oceans (Cheng et al. 2017). In the western North Atlantic, surface temperatures have been unusually warm in recent years (Blunden and Arndt 2016). A study by Polyakov et al. (2009), suggests that the North Atlantic overall has been experiencing a general warming trend over the last 80 years of 0.031 ± 0.006 ºCelsius per decade in the upper 2,000 m of the ocean. Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney et al. 2012). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, tropical storms, heat waves, and droughts (IPCC 2014). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, and susceptibility to disease and contaminants, as well as the timing of seasonal activities and community composition and structure (Evans and Bjørge 2013; IPCC 2014; Kintisch 2006; Learmonth et al. 2006; MacLeod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). Though predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered during this consultation, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring.

Marine species ranges are expected to shift as they align their distributions to match their physiological tolerances under changing environmental conditions (Doney et al. 2012). Hazen et al. (2012) examined top predator distribution and diversity in the Pacific Ocean in light of rising sea surface temperatures using a database of electronic tags and output from a global climate model. They predicted up to a 35 percent change in core habitat area for some key marine predators in the Pacific Ocean, with some species predicted to experience gains in available core habitat and some predicted to experience losses. Notably, leatherback turtles were predicted to gain core habitat area, whereas loggerhead turtles and blue whales were predicted to experience losses in available core habitat. McMahon and Hays (2006) predicted increased ocean temperatures would expand the distribution of leatherback turtles into more northern latitudes. The authors noted this is already occurring in the Atlantic Ocean. MacLeod (2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent predicted to experience unfavorable conditions (e.g., range contraction). Willis-Norton et al. (2015) acknowledge there would be both habitat loss and gain, but overall climate change could result in a 15 percent loss of core pelagic habitat for leatherback turtles in the eastern South Pacific Ocean.

Similarly, climate-related changes in important prey species populations are likely to affect predator populations. For example, blue whales, as predators that specialize in eating krill, are likely to change their distribution in response to changes in the distribution of krill (Clapham et al. 1999; Payne et al. 1986; Payne et al. 1990). Pecl and Jackson (2008) predicted climate change will likely result in squid that hatch out smaller and earlier, undergo faster growth over shorter life-spans, and mature younger at a smaller size. This could have negative consequences for species such as sperm whales, whose diets can be dominated by cephalopods. For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott 2009).

Changes in global climatic patterns are expected to have profound effects on coastlines worldwide, potentially having significant consequences for the ESA-listed sea turtle species considered in this opinion that are partially dependent on terrestrial habitat areas. For example, rising sea levels are projected to inundate some sea turtle nesting beaches (Caut et al. 2009; Wilkinson and Souter 2008), change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and increase the number of sea turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008). The loss of nesting beaches may have catastrophic effects on global sea turtle populations if they are unable to colonize new beaches, or if new beaches do not provide the habitat attributes (e.g., sand depth, temperature regimes, refuge) necessary for egg survival. Additionally, increasing temperatures in sea turtle nests, as is expected with climate change, alters sex ratios, reduces incubation times (producing smaller hatchlings), and reduces nesting success due to exceeded thermal tolerances (Fuentes et al. 2009a; Fuentes et al. 2011; Fuentes et al. 2009b; Glen et al. 2003). However, in some locations, increases in temperature may actually lead to increase in hatching success (Montero et al. 2018). All of these temperature related impacts have the potential to significantly impact sea turtle reproductive success and ultimately, long-term species viability. Poloczanska et al. (2009) noted that extant sea turtle species have survived past climatic shifts, including glacial periods and warming events, and therefore may have the ability to adapt to ongoing climate change (e.g., by finding new nesting beaches). However, the authors also suggested since the current rate of warming is very rapid, expected change may outpace sea turtles' ability to adapt.

Previous warming events (e.g., El Niño, the 1977 through 1998 warm phase of the Pacific Decadal Oscillation) may illustrate the potential consequences of climate change. Off the U.S. west coast, past warming events have reduced nutrient input and primary productivity in the California Current, which also reduced productivity of zooplankton through upper-trophic level consumers (Doney et al. 2012; Sydeman et al. 2009; Veit et al. 1996). In the past, warming events have resulted in reduced food supplies for marine mammals along the U.S. west coast (Feldkamp et al. 1991; Hayward 2000; Le Boeuf and Crocker 2005). Some marine mammal distributions may have shifted northward in response to persistent prey occurrence in more northerly waters during El Niño events (Benson et al. 2002; Danil and Chivers 2005; Lusseau et al. 2004; Norman et al. 2004; Shane 1994; Shane 1995). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio et al. 2005).

This review provides some examples of impacts that may occur as the result of climate change. While it is difficult to accurately predict the consequences of climate change to the species considered in this opinion, a range of consequences, from beneficial to adverse effects are expected.

8.2 Oceanic Temperature Regimes

Oceanographic conditions in the North Atlantic Oceans can be altered due to periodic shifts in atmospheric patterns caused by the North Atlantic oscillation. Such climatic events can alter habitat conditions and prey distribution for ESA-listed species (Beamish 1993; Benson and Trites 2002; Hare and Mantua 2001; Mantua et al. 1997; Mundy 2005; Mundy and Cooney 2005; Stabeno et al. 2004). For example, decade-scale climatic regime shifts have been related to changes in zooplankton in the North Atlantic Ocean (Fromentin and Planque 1996), and decadal trends in the North Atlantic oscillation (Hurrell 1995) can affect the position of the Gulf Stream (Taylor et al. 1998) and other circulation patterns in the North Atlantic Ocean that act as migratory pathways for various marine species, especially fish.

The North Atlantic oscillation is a large-scale, dynamic phenomenon that exemplifies the relationship between the atmosphere and the ocean. The North Atlantic oscillation has global significance as it affects sea surface temperatures, wind conditions, and ocean circulation of the North Atlantic Ocean (Stenseth et al. 2002). The North Atlantic oscillation is an alteration in the intensity of the atmospheric pressure difference between the semi-permanent high-pressure center over the Azores Islands and the sub-polar low-pressure center over Iceland (Stenseth et al. 2002). Sea-level atmospheric pressure in the two regions tends to vary in a “see-saw” pattern – when the pressure increases in Iceland it decreases in the Azores and vice-versa (i.e., the two systems tend to intensify or weaken in synchrony). The North Atlantic oscillation is the dominant mode of decadal-scale variability in weather and climate in the North Atlantic Ocean region (Hurrell 1995).

Since ocean circulation is wind and density driven, it is not surprising to find that the North Atlantic oscillation appears to have a direct effect on the position and strength of important North Atlantic Ocean currents. The North Atlantic oscillation influences the latitude of the Gulf Stream Current and accounts for a great deal of the interannual variability in the location of the current; in years after a positive North Atlantic oscillation index, the north wall of the Gulf Stream (south of New England) is located farther north (Taylor et al. 1998). Not only is the location of the Gulf Stream Current and its end-member, the North Atlantic Current, affected by the North Atlantic oscillation, but the strength of these currents is also affected. During negative North Atlantic oscillation years, the Gulf Stream System (i.e., Loop, Gulf Stream, and North Atlantic Currents) not only shifted southward but weakened, as witnessed during the predominantly negative North Atlantic oscillation phase of the 1960s; during the subsequent 25-year period of predominantly positive North Atlantic oscillation, the currents intensified to a record peak in transport rate, reflecting an increase of 25 to 33 percent (Curry and McCartney 2001). The location and strength of the Gulf Stream System are important, as this major current system is an essential part of the North Atlantic climate system, moderating temperatures and weather from the United States to Great Britain and even the Mediterranean Sea region. Pershing et al. (2001) also found that the upper slope-water system off the east coast of the United States was affected by the North Atlantic oscillation and was driven by variability in temperature and transport of the Labrador Current. During low North Atlantic oscillation periods, especially that seen in the winter of 1996, the Labrador Current intensified, which led to the advance of cold slope water along the continental shelf as far south as the mid-Atlantic Bight in 1998 (Greene and Pershing 2003; Pershing et al. 2001). Variability in the Labrador Current intensity is linked to the effects of winter temperatures in Greenland and its surroundings (e.g., Davis Strait, Denmark Strait), on sea-ice formation, and the relative balance between the formation of deep and intermediate water masses and surface currents.

A strong association has been established between the variability of the North Atlantic oscillation and changes affecting various trophic groups in North Atlantic marine ecosystems on both the eastern and western sides of the basin (Drinkwater et al. 2003; Fromentin and Planque 1996). For example, the temporal and spatial patterns of *Calanus* copepods (zooplankton) were the first to be linked to the phases of the North Atlantic oscillation (Fromentin and Planque 1996; Stenseth et al. 2002). When the North Atlantic oscillation index was positive, the abundance of *Calanus* copepods in the Gulf of Maine increased, with the inverse true in years when the North Atlantic oscillation index was negative (Conversi et al. 2001; Greene et al. 2003b). This pattern is opposite off the European coast (Fromentin and Planque 1996). Such a shift in copepod patterns has a tremendous significance to upper-trophic-level species, including the North Atlantic right whale, which feeds principally on *Calanus finmarchicus*. North Atlantic right whale calving rates are linked to the abundance of *C. finmarchicus*. In years when the North Atlantic Oscillation Index is positive and sea surface temperatures and *C. finmarchicus* abundance increase, North Atlantic right whale calving rates generally increase, although there may be some lag in timing (Greene et al. 2003a). In years when the index is negative and sea surface temperatures and the abundance of *C. finmarchicus* decrease, North Atlantic right whale calving rates in subsequent years decrease (Drinkwater et al. 2003; Greene et al. 2003a; Pershing et al. 2010). In addition, when the North Atlantic Oscillation Index is low with subsequently warmer water temperatures off Labrador and the Scotian Shelf, recruitment of cod appears to be higher. Furthermore, direct links to the North Atlantic Oscillation phase have also been found for recruitment in the North Atlantic of herring, two tuna species, Atlantic salmon, and swordfish (Drinkwater et al. 2003).

From 2000 to 2007, the abundance of *C. finmarchicus* has been relatively high, leading to increases in North Atlantic right whale calving rates (Meyer-Gutbrod and Greene 2014). However, in more recent years North Atlantic right whale calving rates appear to be low (see Section 7.2.3.4). However, climate change models suggest that increases in ocean temperature may produce more severe fluctuations in the North Atlantic Oscillation, which may cause dramatic shifts in the reproductive rate of North Atlantic right whales (Drinkwater et al. 2003; Greene et al. 2003a). Furthermore, evaluation of changes in *C. finmarchicus* abundance under multiple climate change scenarios indicate *C. finmarchicus* density is likely to decrease in the North Atlantic, in some cases by as much as 50 percent by 2081-2100 (Grieve et al. 2017). Thus, regardless of the North Atlantic Oscillation, North Atlantic right whales are likely to experience a significant decline in their primary prey in the near future.

8.3 Disease

Green sea turtles are susceptible to natural mortality from Fibropapillomatosis disease. Fibropapillomatosis results in the growth of tumors on soft external tissues (e.g., flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (e.g., gastrointestinal tract, heart, lungs, etc.; Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Tumors range in size from 0.1 cm to greater than 30 cm in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, but it is likely related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions (e.g., habitat degradation, pollution, low wave energy, and shallow water) (Foley et al. 2005). Fibropapillomatosis is cosmopolitan, but it affects large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991). In the eastern United States, 22.6 percent of stranded green turtles had tumors consistent with Fibropapillomatosis (Foley et al. 2005). While the disease appears to have regressed over time (Chaloupka et al. 2009), it persists in at levels of spatial variability (Hargrove et al. 2016).

8.4 Invasive Species

Invasive species have been referred to as one of the top four threats to the world’s oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002). A variety of vectors are thought to have introduced non-native species including, but not limited to, aquarium and pet trades, recreation, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010). Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. Invasive species have been implicated in the endangerment of 48 percent of ESA-listed species (Czech and Krausman 1997).

8.5 Pollution

Anthropogenic activities such as discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture, and additional impacts from coastal development are known to degrade coastal waters utilized by ESA-listed marine mammals and sea turtles in the action area. Multiple municipal, industrial, and household sources as well as atmospheric transport introduce various pollutants such as pesticides, hydrocarbons, organochlorides, and other pollutants that may cause adverse health effects to ESA-listed marine mammals (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993; Ross 2002). Acute toxicity events may result in mass mortalities; repeated exposure to lower level contaminants may result in immune suppression and/or endocrine disruption in marine mammals (Atkinson et al. 2008). The accumulation of persistent pollutants through trophic transfer may cause mortality and sub-lethal effects including immune systems abnormalities, endocrine disruption and reproductive effects (Krahn et al. 2007). The water quality in the eastern United States is particularly at risk given the high population density, although there is evidence that pollutants from some sources may be declining (Brown and Froemke 2012).

8.5.1 Marine Debris

Debris can be introduced into the marine environment by its improper disposal, accidental loss, transport from land-based sources, or natural disasters (e.g., continental flooding and tsunamis) (Watters et al. 2010), and can include plastics, glass, polystyrene foam, rubber, derelict fishing gear, derelict vessels, or military expendable materials. Marine debris accumulates in gyres throughout the oceans. Despite debris removal and outreach to heighten public awareness, marine debris in the environment has not been reduced (NRC 2008) and continues to accumulate in the ocean and along shorelines within the action area.

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it (Gall and Thompson 2015). Entanglement in marine debris can lead to injury, infection, reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for all ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including sea turtles and cetaceans. Marine debris ingestion can lead to intestinal blockage, which can impact feeding ability and lead to injury or death. Data on marine debris in some locations of the action area is largely lacking; therefore, it is difficult to draw conclusions as to the extent of the problem and its impacts on populations of ESA-listed species.

Sea turtles can mistake plastic bags for jellyfish, which are eaten by sea turtle species in early life phases, and exclusively by leatherback turtles throughout their lives. One study found plastic in 37 percent of dead leatherback turtles and determined that nine percent of those deaths were a direct result of plastic ingestion (Mrosovsky et al. 2009). Across sea turtle species, a recent study found that there was a 50 percent probability of mortality for sea turtles that ingested 14 pieces of plastic (Wilcox et al. 2018). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown sea turtles of all life stages. In a study on marine debris ingestion in 115 green and hawksbill turtles stranded in Queensland, Schuyler et al. (2012) found that the probability of debris ingestion was inversely correlated with size (curved carapace length), and when broken down into size classes, smaller pelagic sea turtles were significantly more likely to ingest debris than larger benthic feeding turtles. Parker et al. (2005) conducted a diet analysis of 52 loggerhead turtles collected as bycatch from 1990 to 1992 in the high seas drift gillnet fishery in the central north Pacific Ocean. The authors found that 34.6 percent of the individuals sampled had anthropogenic debris in their stomachs (e.g., plastic, Styrofoam, paper, rubber, etc.). Similarly, a study of green turtles found that 61 percent of those observed stranded had ingested some form of marine debris, including rope or string, which may have originated from fishing gear (Bugoni et al. 2001). A recent global analysis indicates that risk of ingestion may vary by species, with hawksbill and green sea turtles ingesting more debris than other species, and ingestion rates are particularly high in the Central Northwest Pacific and Southwest Atlantic and relatively low off the coast of the United States including the action area (Lynch 2018).

Ingestion of marine debris has been reported in cetaceans as well. In 2008, two sperm whales stranded along the California coast, with an assortment of fishing related debris (e.g., net scraps, rope) and other plastics inside their stomachs (Jacobsen et al. 2010). One whale was emaciated, and the other had a ruptured stomach. It was suspected that gastric impaction was the cause of both deaths. Jacobsen et al. (2010) speculated that the debris likely accumulated over many years, possibly in the North Pacific gyre that would carry derelict Asian fishing gear into eastern Pacific waters (Jacobsen et al. 2010).

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as PCB and DDT. Fish, marine mammals, and sea turtles can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. It is expected that marine mammals and sea turtles may be exposed to marine debris over the course of the action although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

8.5.2 Pesticides and Contaminants

Exposure to pollution and contaminants has the potential to cause adverse health effects in marine species. Marine ecosystems receive pollutants from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor (Grant and Ross 2002). Marine pollutants come from multiple municipal, industrial, and household sources as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993). Contaminants at various degrees may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation (Garrett 2004; Grant and Ross 2002; Hartwell 2004).

The accumulation of persistent pollutants through trophic transfer may cause mortality and sub-lethal effects in long-lived high trophic level animals such as marine mammals (Waring et al. 2004), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007). Some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants (O'Hara and Rice 1996). Recent efforts have led to improvements in water quality in some areas outside the action area (e.g., Puget

Sound) and monitored pesticide levels have declined, although the more persistent chemicals are still detected and are expected to endure for years (Grant and Ross 2002; Mearns 2001).

In sea turtles, heavy metals have been found in a variety of tissues in levels that increase with sea turtle size (Anan et al. 2001; Barbieri 2009; Fujihara et al. 2003; García-Fernández et al. 2009; Gardner et al. 2006; Godley 1999; Sakai et al. 2000; Storelli et al. 2008). Cadmium has been found in leatherback turtles at the highest concentration compared to any other marine vertebrate (Caurant et al. 1999; Gordon et al. 1998). Newly emerged hatchlings have higher concentrations than are present when laid, suggesting that metals may be accumulated during incubation from surrounding sands (Sahoo et al. 1996). Arsenic has been found to be very high in green turtle eggs (Van De Merwe et al. 2009).

Sea turtle tissues have been found to contain organochlorines (Alava et al. 2006; Corsolini et al. 2000; Keller et al. 2005; Keller et al. 2004a; McKenzie et al. 1999; Monagas et al. 2008; Oros et al. 2009; Rybitski et al. 1995; Storelli et al. 2007). Concentrations of polychlorinated biphenyls (PCB) are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500 to 530 ng/g wet weight) (Davenport et al. 1990; Oros et al. 2009). Levels of PCBs found in green turtle eggs are considered far higher than what is fit for human consumption (Van De Merwe et al. 2009).

Organochlorines have the potential to suppress the immune system of loggerhead turtles and may affect metabolic regulation (Keller et al. 2006; Keller et al. 2004b; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007), and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation. Exposure to sewage effluent may also result in green turtle eggs harboring antibiotic resistant strains of bacteria (Al-Bahry et al. 2009).

8.5.3 Oil Spill

There has never been a large-scale oil spill in the action area, but numerous small-scale vessel spills likely occur. A nationwide study examining vessel oil spills from 2002 to 2006 found that over 1.8 million gallons of oil were spilled from vessels in all U.S. waters (Dalton and Jin 2010). In this study, “vessel” included numerous types of vessels, including barges, tankers, tugboats, and recreational and commercial vessels, demonstrating that the threat of an oil spill can come from a variety of type of boats. Below we review the effects of oil spills on marine mammals and sea turtles more generally. Much of what is known comes from studies of large oil spills such as the Deepwater Horizon oil spill (DWH) since no information exists on the effects of small-scale oil spills within the action area.

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to marine species. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). The DWH oil spill in the Gulf of Mexico in 2010 led to the exposure of tens of thousands of marine mammals to oil, causing reproductive failure, adrenal disease, lung disease, and poor body condition. Sea turtles were also impacted, being mired and killed by oil at the water's surface. Exposure also occurred via ingestion, inhalation, and maternal transfer of oil compounds to embryos; these effects are more difficult to assess, but likely resulted in sub-lethal effects and injury (Deepwater Horizon Trustees 2016).

Cetaceans have a thickened epidermis that greatly reduces the likelihood of petroleum toxicity from skin contact with oils (Geraci 1990), but they may inhale these compounds at the water's surface and ingest them while feeding (Matkin and Saulitis 1997). For example, as a result of the DWH spill, sperm whales could have been exposed to toxic oil components through inhalation, aspiration, ingestion, and dermal exposure. There were 19 observations of 33 sperm whales swimming in DWH surface oil or that had oil on their bodies (Diaz 2015 as cited in Deepwater Horizon Trustees 2016). The effects of oil exposure likely included physical and toxicological damage to organ systems and tissues, reproductive failure, and death. Whales may have experienced multiple routes of exposure at the same time, over intermittent timeframes and at varying rates, doses, and chemical compositions of oil based on observed impacts to bottlenose dolphins. Hydrocarbons also have the potential to impact cetacean prey and therefore may affect ESA-listed cetaceans indirectly by reducing food availability.

Oil can also be hazardous to sea turtles, with direct contact with oil causing significant mortality and morphological changes in hatchlings (Fritts and McGehee 1981). For example, the DWH oil spill extensively oiled vital foraging, migratory, and breeding habitats of sea turtles throughout the northern Gulf of Mexico (Deepwater Horizon Trustees 2016). *Sargassum* habitats, benthic foraging habitats, surface and water column waters, and sea turtle nesting beaches were all affected by the DWH oil spill. Sea turtles may have been exposed to DWH oil in contaminated habitats, through breathing oil droplets, oil vapors, and smoke, by ingesting oil-contaminated water and prey, and through maternal transfer of oil compounds to developing embryos. Translocation of eggs from the Gulf of Mexico to the Atlantic coast of Florida resulted in the loss of sea turtle hatchlings. High numbers of small oceanic and large sea turtles are estimated to have been exposed to oil resulting from the DWH spill due to the duration and large footprint of the spill. It was estimated that as many 7,590 large juvenile and adult sea turtles (Kemp's ridley, loggerhead, and unidentified hardshell sea turtles), and up to 158,900 small juvenile sea turtles (Kemp's ridley, green, loggerhead, hawksbill, and hardshell sea turtles not identified to species) were killed by the DWH oil spill. Small juveniles were affected in the greatest numbers and suffered a higher mortality rate than large sea turtles. Leatherback foraging and migratory habitat was also affected and though impacts to leatherbacks were unquantified, it is likely some died as a result of the DWH spill and spill response (Deepwater Horizon Trustees 2016; NMFS and USFWS 2013b).

As noted above, to our knowledge the past and present impacts of oil spills on ESA-listed species within the action area are limited to those associated with small-scale vessel spills. Nevertheless, we consider the documented effects of oils spills outside the action area, such the DWH oil spill, examples of the possible impacts oil spills can have on ESA-listed species.

8.6 Fisheries

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions on marine mammals and sea turtles include entanglement and entrapment, which can lead to fitness consequences or mortality as a result of injury or drowning. Indirect effects include reduced prey availability, including overfishing of targeted species, and destruction of habitat. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Fisheries can have a profound influence on fish populations. In a study of retrospective data, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al. 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations.

8.7 Bycatch

The term "bycatch" refers to any fisheries capture that is incidental to the intended or targeted species and can encompass all unwanted, unmanaged, or discarded animals captured. Bycatch in the action area occurs both as a result of nearshore fisheries as well as large-scale offshore fisheries operated by foreign fishing fleets. Bycatch has been identified as a primary driver of population declines in several groups of marine species, including sharks, mammals, marine birds, and sea turtles (Gray and Kennelly 2018; Wallace et al. 2010a). Bycatch is likely the most impactful problem presently facing cetaceans worldwide and may account for the deaths of more marine mammals than any other cause (Geijer and Read 2013; Hamer et al. 2010; Northridge 2009; Read 2008). Smaller cetaceans are prone to bycatch in longline, trawl and purse seine fisheries, while large whales are prone to entanglement in trap or pot fisheries (FAO 2018).

Entanglement may also make whales more vulnerable to additional dangers, such as predation and vessel strikes, by restricting agility and swimming speed. A summary of the most recent five years of data (2011 to 2015 for baleen whales, 2008 to 2012 for sperm whales) on mortalities and serious injuries related to entanglement of ESA-listed cetacean stocks within U.S. waters likely to be found in the action areas are given in Table 6 below (Hayes et al. 2018b; Henry et al. 2017). These data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries have likely occurred. In addition, these data do not include the recent deaths of North Atlantic right whales associated with the June 2017 UME (see discussion in Section 7.2.3.4).

Table 6. Latest five-year incidents of mortality and serious injury related to entanglement in fishing gear.

Species	Number of Entanglements	Annual Average
Blue whales	0	0
Fin whales	10	2
North Atlantic right whales	24	4.8
Sei whales	0	0
Sperm whales	2	0.4

Fishery interaction remains a major factor affecting sea turtle recovery. Wallace et al. (2010b) estimated that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries. NMFS (2002) estimated that 62,000 loggerhead turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. It is likely that the majority of individual sea turtles and marine mammals that are killed by commercial fishing gear are never detected, making it very difficult to accurately determine the number and frequency of mortalities. Although sea turtle excluder devices and other bycatch reduction devices have significantly reduced the level of bycatch to sea turtles and other marine species in U.S. waters, mortality still occurs.

8.8 Aquaculture

Aquaculture has the potential to impact protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic and noise, impacts to habitat and benthic organisms, and water quality (Clement 2013; Lloyd 2003; Price et al. 2017; Price and Morris 2013). Current data suggest that interactions and entanglements of ESA-listed marine mammals and sea turtles with aquaculture gear are rare (Price et al. 2017). This may be because worldwide the number and density of aquaculture farms are low, and thus there is a low probability of interactions, or because they pose little risk to ESA-listed marine mammals and sea turtles. Nonetheless, given that in some aquaculture gear, such as that used in longline mussel farming, is similar to gear used in commercial fisheries, aquaculture may impacts similar to fisheries and bycatch, as discussed above in Sections 8.6 and 8.7 respectively. There are very few reports of marine mammal interactions with aquaculture gear in the U.S. Atlantic, although it is not always possible to determine if the gear animals become entangled in is from aquaculture or commercial fisheries (Price et al. 2017). However, there is at least one report of a North Atlantic right whale becoming entangled in unidentified aquaculture gear (Johnson et al. 2005). There are relatively few studies on the impacts of aquaculture on sea turtles, but there are several reports of sea turtles outside the action area, but within the North Atlantic, becoming entangled in aquaculture ropes (Price et al. 2017).

8.9 Whaling

Large whale population numbers in the action area have historically been impacted by aboriginal hunting and commercial exploitation, mainly in the form of whaling. From 1864 through 1985, at least 2,400,000 baleen whales (excluding minke whales) and sperm whales were killed (Gambell 1999). During this period of modern commercial whaling, approximately 50,000 whales were removed annually (Gambell 1999). Prior to current prohibitions on whaling, most large whale species were significantly depleted to the extent it was necessary to list them as endangered under the Endangered Species Preservation Act of 1966. In 1982, the International Whaling Commission issued a moratorium on commercial whaling, which began being instituted in 1986. There is currently no legal commercial whaling by International Whaling Commission Member Nations party to the moratorium; however, whales are still killed commercially by countries that filed objections to the moratorium (i.e., Iceland and Norway). Presently three types of whaling take place: (1) aboriginal subsistence whaling to support the needs of indigenous people; (2) special permit whaling; and (3) commercial whaling conducted either under objection or reservation to the moratorium. The reported catch and catch limits of large whale species from aboriginal subsistence whaling, special permit whaling, and commercial whaling can be found on the International Whaling Commission’s website at: https://iwc.int/whaling. Additionally, the Japanese whaling fleet carries out whale hunts under the guise of “scientific research,” though very few peer-reviewed papers have been published as a result of the program, and meat from the whales killed under the program is processed and sold at fish markets.

Norway and Iceland take whales commercially at present, either under objection to the moratorium decision or under reservation to it. These countries establish their own catch limits but must provide information on those catches and associated scientific data to the International Whaling Commission. The Russian Federation has also registered an objection to the moratorium decision but does not exercise it. The moratorium is binding on all other members of the International Whaling Commission. Norway takes minke whales in the North Atlantic Ocean within its EEZ, and Iceland takes minke whales and fin whales in the North Atlantic Ocean, within its EEZ (IWC 2012).

Under current International Whaling Commission regulations, aboriginal subsistence whaling is permitted for Denmark (Greenland, fin and minke whales, *Balaenoptera* sp.), the Russian Federation (Siberia, gray, *Eschrichtius robustus*, and bowhead, *Balaena mysticetus*, whales), St. Vincent and the Grenadines (Bequia, humpback whales, *Megaptera novaeangliae*) and the United States (Alaska, bowhead, and gray whales). It is the responsibility of national governments to provide the International Whaling Commission with evidence of the cultural and subsistence needs of their people. The Scientific Committee provides scientific advice on safe catch limits for such stocks (IWC 2012). Based on the information on need and scientific advice, the International Whaling Commission then sets catch limits, recently in five-year blocks.

Scientific permit whaling has been conducted by Japan and Iceland. In Iceland, the stated overall objective of the research program was to increase understanding of the biology and feeding ecology of important cetacean species in Icelandic waters for improved management of living marine resources based on an ecosystem approach. While Iceland stated that its program was intended to strengthen the basis for conservation and sustainable use of cetaceans, it noted that it was equally intended to form a contribution to multi-species management of living resources in Icelandic waters. Although these whaling activities operate outside of the action area, the whales killed in these whaling expeditions are part of the population of whales (e.g., fin and sei) occurring within the action area for this consultation.

Many of the whaling numbers reported represent minimum catches, as illegal or underreported catches are not included. For example, recently uncovered Union of Soviet Socialists Republics catch records indicate extensive illegal whaling activity between 1948 and 1979 (Ivashchenko et al. 2014). Additionally, despite the moratorium on large-scale commercial whaling, catch of some of these species still occurs in the Atlantic Ocean whether it be under objection of the International Whaling Commission, for aboriginal subsistence purposes, or under International Whaling Commission scientific permit 1985 through 2013. Some of the whales killed in these fisheries are likely part of the same population of whales occurring within the action area for this consultation.

Historically, commercial whaling caused all of the large whale species to decline to the point where they faced extinction risks high enough to list them as endangered species. Since the end of large-scale commercial whaling, the primary threat to these species has been eliminated. However, as described in greater detail in Section 7.2 of this opinion, many whale species have not yet fully recovered from those historic declines. Scientists cannot determine if those initial declines continue to influence current populations of most large whale species in the Atlantic Ocean. For example, the North Atlantic right whale has not recovered from the effects of commercial whaling and continue to face very high risks of extinction because of their small population sizes and low population growth rates. In contrast, populations of species such as the humpback whale have increased substantially from post-whaling population levels and appear to be recovering despite the impacts of vessel strikes, interactions with fishing gear, and increased levels of ambient sound.

8.10 Sea Turtle Harvest

Directed harvest of sea turtles and their eggs for food and other products has existed for years and was a significant factor causing the decline of green, Kemp's ridley, leatherback, and loggerhead turtles. In the United States, the harvest of nesting sea turtles and eggs is now illegal;

however, poaching is a problem on some beaches (Ehrhart and Witherington 1987). Nesting adults and eggs continue to be harvested legally and illegally in other nations (Benson et al. 2007; Benson et al. 2011).

8.11 Scientific Research

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Scientific research permits issued by NMFS currently authorize studies on ESA-listed species in the Atlantic Ocean, some of which occur in portions of the action area. Marine mammals and sea turtles have been the subject of field studies for decades. The primary objective of most of these field studies has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of "take" of marine mammals and sea turtles in the action area from a variety of research activities.

Authorized research on ESA-listed whales and dolphins includes close vessel and aerial approaches, photographic identification, photogrammetry, biopsy sampling, tagging, ultrasound, exposure to acoustic activities, breath sampling, behavioral observations, passive acoustic recording, and underwater observation. Research activities involve non-lethal "takes" of these whales and dolphins.

ESA-listed sea turtle research includes approach, capture, handling, restraint, tagging, biopsy, blood or tissue sampling, lavage, ultrasound, imaging, antibiotic (tetracycline) injections, laparoscopy, captive experiments, and mortality. Most authorized take is sub-lethal with some resulting in mortality.

8.12 Vessel Strike

Vessels have the potential to affect animals through strikes, sound, and disturbance by their physical presence. Vessel strike is a significant and widespread concern for the recovery of ESA-listed marine mammals and sea turtles. This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995). As vessels continue to become faster and more widespread, an increase in vessel interactions with marine mammals is expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by vessels 80 m (262.5 feet) or longer (Laist et al. 2001). For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above 26 km per hour (14 knots) (Laist et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination

(Glass et al. 2010). Most whales killed by vessel strike likely end up sinking rather than washing up on shore, and it is estimated that 17 percent of vessel strikes of North Atlantic right whales are actually detected (Kraus et al. 2005). Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of mortalities associated with vessel strikes, especially for less buoyant species such as blue, humpback, and fin whales (Rockwood et al. 2017). Rockwood et al. (2017) modeled ship strike mortalities of blue, humpback and fin whales off California using carcass recovery rates of five and 17 percent and conservatively estimated that vessel strike mortality may be as high as 7.8, 2.0, and 2.7 times the recommended limit for blue, humpback and fin whales stocks in this area respectively.

Of the 11 species known to be hit by vessels, in the northern hemisphere fin whales are stuck most frequently, but right whales, humpback whales, sperm whales, and gray whales are also struck (Laist et al. 2001; Peel et al. 2018; Vanderlaan and Taggart 2007). In some areas, one-third of all fin whale and right whale strandings appear to involve vessel strikes (Laist et al. 2001). The effects of vessel strikes are particularly profound on species with low abundance, such as North Atlantic right whales. Vessel strikes represent one of the greatest threats to the continued existence of North Atlantic right whales. Between 1999 and 2006, vessels were confirmed to have struck 22 North Atlantic right whales, killing 13 of these whales (Jensen and Silber 2004; Knowlton and Kraus 2001; NMFS 2005). From 2006 to 2010, 10 instances of mortality stemming from vessel collision were documented (Waring et al. 2013). However, with the implementation of the 2008 mandatory right whale vessel strike reduction rule and increased communication through the usage of the Automatic Identification System, reported instances of North Atlantic right whale mortalities from vessel strikes have significantly decreased (Conn and Silber 2013). As a result of the rule, speed restrictions of 10 knots or less for vessels 65 feet in length or greater were implemented for several areas along the western Atlantic during specified times of the year (50 C.F.R. §224.105). From 2008 to 2014 only two reported instances of mortalities were recorded for North Atlantic right whales due to vessel strike, resulting in a nearly 80 to 90 percent reduction of occurrence from previous time spans (Henry et al. 2015; Henry et al. 2016; Waring et al. 2015). However, at least one calf was struck and killed by a vessel in 2016 (Fernández Ajó et al. 2018), and the results of necropsies for five of the North Atlantic right whales found dead in the 2017 UME indicate evidence of blunt force trauma consistent with vessel strikes (Daoust et al. 2017).

A summary of the most recent five years of data (2011 to 2015 for baleen whales, 2008 to 2012 for sperm whales) on mortalities and serious injuries related to vessel strikes of ESA-listed cetacean stocks within U.S. waters likely to be found in the action areas are given in Table 7 below (Hayes et al. 2018b; Henry et al. 2017). These data represent only known mortalities and serious injuries; more undocumented mortalities and serious injuries have likely occurred. In addition, these data do not include the recent deaths of North Atlantic right whales associated with the ongoing UME.

Table 7. Latest five-year incidents of mortality and serious injury related to vessel strikes.

Species	Number of Vessel Strikes	Annual Average
Blue whales	0	0
Fin whales	8	1.6
North Atlantic right whales	5	1
Sei whales	4	0.8
Sperm whales	1	0.2

Vessel strikes are a poorly-studied threat to sea turtles, but have the potential to be highly significant given that they can result in serious injury and mortality (Work et al. 2010). All sea turtles must surface to breathe and several species are known to bask at the surface for long periods. Although sea turtles can move somewhat rapidly, they apparently are not adept at avoiding vessels that are moving at more than 4 km per hour; most vessels move far faster than this in open water (Hazel and Gyuris 2006; Hazel et al. 2007; Work et al. 2010). Both live and dead sea turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al. 2007). Hazel et al. (2007) suggests that green turtles may use auditory cues to react to approaching vessels rather than visual cues, making them more susceptible to strike as vessel speed increases.

8.13 Vessel Approaches – Commercial and Private Marine Mammal Watching

Whale watching is a rapidly growing business with more than 3,300 operators worldwide, serving 13 million participants in 119 countries and territories (O'Connor et al. 2009). As of 2010, commercial whale watching was a one billion dollar global industry per year (Lambert et al. 2010). Private vessels may partake in this activity as well. NMFS has issued certain regulations and guidelines relevant to whale watching. As noted previously, many of the cetaceans considered in this opinion are highly migratory, so may also be exposed to whale watching activity occurring outside of the action area.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational, and scientific benefits, marine mammal watching is not without potential negative impacts (reviewed in Machernis et al. 2018). Whale watching has the potential to harass whales by altering feeding, breeding, and social behavior or even injure them if the vessel gets too close or strikes the whale. Preferred habitats may be abandoned if disturbance levels are too high. Animals may also become more vulnerable to vessel strikes if they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995).

Several studies have examined the short-term effects of whale watch vessels on marine mammals (Au and Green 2000; Corkeron 1995; Erbe 2002; Felix 2001; Magalhaes et al. 2002; Richter et al. 2003; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel sound, and the number of vessels. In some circumstances, whales do not appear to respond to vessels, but in other circumstances, whales change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Disturbance by whale watch vessels has also been noted to cause newborn calves to separate briefly from their mother's sides, which leads to greater energy expenditures by the calves (NMFS 2006d)

Although numerous short-term behavioral responses to whale watching vessels are documented, little information is available on whether long-term negative effects result from whale watching (NMFS 2006d). Christiansen et al. (2014) estimated the cumulative time minke whales spent with whale watching boats in Iceland to assess the biological significance of whale watching disturbances and found that, though some whales were repeatedly exposed to whale watching boats throughout the feeding season, the estimated cumulative time they spent with boats was very low. Christiansen et al. (2014) suggested that the whale watching industry, in its current state, is likely not having any long-term negative effects on vital rates.

It is difficult to precisely quantify or estimate the magnitude of the risks posed to marine mammals in general from vessel approaches associated with whale watching. Given the proposed seismic activities will not occur in areas within 30 km of land (year-round), few whale watching boats would be expected to co-occur with the action's vessels.

8.14 Conservation and Management Efforts

Several conservation and management efforts have been undertaken for marine mammals and sea turtles in the action area. Recovery plans guide the protection and conservation of these species (NMFS 1991). NMFS implements conservation and management activities for the species through its regional offices and fishery science centers in cooperation with states, conservation groups, the public, and other federal agencies. A non-exhaustive list of conservation and management actions are below:

- Observers are placed aboard some fishing vessels and vessels engaged in seismic surveys to record and monitor impacts to protected species
- Take reduction plans have required acoustic pingers to help repel marine mammals from fishing operations
- NMFS mitigates vessel strikes and responds to whales in distress
- Together with their partners, NMFS educates the crew of whale watch vessels and other boat operators on safe boating practices
- NMFS has implemented a series of regulations aimed at reducing potential for incidental mortality of sea turtles from commercial fisheries in the action area
- NMFS oversees an extensive network of Sea Turtle Stranding and Salvage Network participants along the Atlantic and Gulf of Mexico coasts who not only collect data on dead sea turtles, but also rescue and rehabilitate live stranded sea turtles

Conservation and management efforts for marine mammals and sea turtles are also implemented independent of NMFS. For example, and most notably for cetaceans, in 1946, the International

Convention for the Regulation of Whaling began regulating commercial whaling and in 1966, the International Whaling Commission prohibited commercial whaling.

8.15 Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of anthropogenic sounds. These include, but are not limited to: maritime activities, dredging, construction, mineral exploration in offshore areas, geophysical (seismic) surveys, sonar, explosions, and ocean research activities. ESA-listed species have the potential to be impacted by either increased levels of anthropogenic-induced background sound or high intensity, short-term anthropogenic sounds.

Anthropogenic sound is generated by commercial and recreational vessels, aircraft, commercial sonar, military activities, seismic surveys, in-water construction activities, and other human activities. These activities occur within the action area to varying degrees throughout the year. The scientific community recognizes the addition of anthropogenic sound to the marine environment as a stressor that could possibly harm marine animals or significantly interfere with their normal activities (NRC 2005). The species considered in this opinion may be impacted by anthropogenic sound in various ways. Once detected, some sounds may produce a behavioral response, including but not limited to, changes in habitat to avoid areas of higher sound levels, changes in diving behavior, or (for cetaceans) changes in vocalization (MMC 2007).

Many researchers have described behavioral responses of marine mammals to the sounds produced by boats and vessels, as well as other sound sources such as helicopters and fixed-wing aircraft, and dredging and construction (reviewed in Gomez et al. 2016; and Nowacek et al. 2007). Most observations have been limited to short-term behavioral responses, which included avoidance behavior and temporary cessation of feeding, resting, or social interactions; however, in terrestrial species habitat abandonment can lead to more long-term effects, which may have implications at the population level (Barber et al. 2010). Masking may also occur, in which an animal may not be able to detect, interpret, and/or respond to biologically relevant sounds. Masking can reduce the range of communication, particularly long-range communication, such as that for blue and fin whales. This could have a variety of implications for an animal's fitness including, but not limited to, predator avoidance and the ability to reproduce successfully (MMC 2007). Recent scientific evidence suggests that marine mammals, including several baleen whales, compensate for masking by changing the frequency, source level, redundancy, or timing of their signals, but the long-term implications of these adjustments are currently unknown (McDonald et al. 2006a; Parks 2003; Parks 2009).

Despite the potential for these impacts to affect individual ESA-listed marine mammals and sea turtles, information is not currently available to determine the potential population level effects of anthropogenic sound levels in the marine environment (MMC 2007). For example, we currently lack empirical data on how sound impacts growth, survival, reproduction, and vital rates, nor do we understand the relative influence of such effects on the population being considered. As a result, the consequences of anthropogenic sound on threatened and endangered marine mammals and sea turtles at the population or species scale remain uncertain, although recent efforts have made progress establishing frameworks to consider such effects (NAS 2017).

8.15.1 Seismic Surveys

Seismic surveys similar to those being considered as part of the proposed action have occurred in the action area for scientific research and/or geophysical purposes and for oil and gas exploration. As discussed in Section 3, seismic airguns generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of 10 to 20 seconds for extended periods (NRC 2003). Most of the energy from the guns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns usually reach 235 to 240 decibels at dominant frequencies of 5 to 300 Hz (NRC 2003). Most of the sound energy is at frequencies below 500 Hz. Given that the proposed action involves seismic surveys, the anticipated effects of seismic surveys to ESA-listed species and designated critical habitat are discussed extensively throughout this opinion (see Sections 7.1 and 9.2). As such, we do not elaborate on them further here but note that sounds from past seismic surveys contributes to the environmental baseline within the action area.

8.15.2 Vessel Sound and Commercial Shipping

Much of the increase in sound in the ocean environment is due to increased shipping, as vessels become more numerous and of larger tonnage (Hildebrand 2009b; McKenna et al. 2012; NRC 2003). Shipping constitutes a major source of low-frequency sound in the ocean, particularly in the Northern Hemisphere where the majority of vessel traffic occurs. Although large vessels emit predominantly low frequency sound, studies report broadband sound from large cargo vessels above 2 kHz, which may interfere with important biological functions of cetaceans (Holt 2008). At frequencies below 300 Hz, ambient sound levels are elevated by 15 to 20 dB when exposed to sounds from vessels at a distance (McKenna et al. 2013). Analysis of sound from vessels revealed that their propulsion systems are a dominant source of radiated underwater sound at frequencies less than 200 Hz (Ross 1976). Additional sources of vessel sound include rotational and reciprocating machinery that produces tones and pulses at a constant rate.

Individual vessels produce unique acoustic signatures, although these signatures may change with vessel speed, vessel load, and activities that may be taking place on the vessel. Peak spectral levels for individual commercial vessels are in the frequency band of 10 to 50 Hz and range from 195 dB re: μPa^2-s at 1 m for fast-moving (greater than 20 knots) supertankers to 140 dB re: μPa^2-s at 1 m for small fishing vessels (NRC 2003). Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency (1 to 5 kHz) range and at moderate (150 to 180 dB re: 1 μPa at 1 m) source levels (Erbe 2002; Gabriele et al. 2003; Kipple and Gabriele 2004). On average, sound levels are higher for the larger vessels, and increased vessel speeds result in higher sound levels. Measurements made over the period 1950 through 1970 indicated low frequency (50 Hz) vessel traffic sound in the eastern North Pacific and western

North Atlantic Oceans was increasing by 0.55 dB per year (Ross 1976; Ross 1993; Ross 2005). Whether or not such trends continue today is unclear. Most data indicate vessel sound is likely still increasing (Hildebrand 2009a). However, the rate of increase appears to have slowed in some areas (Chapman and Price 2011), and in some places, ambient sound including that produced by vessels appears to be decreasing (Miksis-Olds and Nichols 2016). Efforts are underway to better document changes in ambient sound (Haver et al. 2018), which will help provide a better understanding of current and future impacts of vessel sound on ESA-listed species.

8.15.3 Air Force Training and Testing Activities

The Air Force conducts training and testing activities on range complexes on land and in U.S. waters. Aircraft operations and air-to-surface activities may occur in the action area (e.g., off Florida). Air Force activities generally involve the firing or dropping of munitions (e.g., bombs, missiles, rockets, and gunnery rounds) from aircraft towards targets located on the surface, though Air Force training exercises may also involve boats. These activities have the potential to impact ESA-listed species by physical disturbance, boat strikes, debris, ingestion, and effects from sound and pressure produced by detonations. Air Force training and testing activities constitute a federal action and take of ESA-listed species considered for these Air Force activities have previously undergone separate section 7 consultation.

8.15.4 Navy Range Complex Training and Testing Activities

The Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the United States and on the high seas. Activities are conducted off the Atlantic coast and elsewhere throughout the world. During training, existing and established weapon systems and tactics are used in realistic situations to simulate and prepare for combat. Activities include routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include at-sea research, development, evaluation, and experimentation. The Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them. The majority of the training and testing activities the Navy conducts in the action area are similar, if not identical, to activities that have been occurring in the same locations for decades.

Navy activities produce sound and visual disturbances to marine mammals and sea turtles throughout the action area (NMFS 2015b; NMFS 2015c; NMFS 2017f). Anticipated impacts from harassment due to Navy activities include changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that require higher energy expenditures. Based on the currently available scientific information, behavioral responses that result from stressors associated with these training and testing activities are expected to be temporary and would not affect the reproduction, survival, or recovery of these species. Sound produced during Navy training and testing activities is also expected to result in instances of temporary and permanent threshold shift to marine mammals and sea turtles. The Navy training and testing activities constitute a federal action and take of ESA-listed marine mammals and sea turtles considered for these Navy activities have previously undergone separate section 7 consultation. Through these consultations with NMFS, the Navy has implemented monitoring and conservation measures to reduce the potential effects of underwater sound from military training and testing activities on ESA-listed resources in the Atlantic Ocean. Conservation measures include employing visual observers and implementing mitigation zones when training and testing using active sonar or explosives.

8.15.5 Navy Active Sonar Routine Training, Testing, and Military Operations

Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar is the towed array sonar system of the Navy, and represents another sound source in the action area. SURTASS LFA has a coherent low frequency signal with a duty cycle of less than 20 percent, operating for a maximum of only 255 hours per year for each system (or 432 hours per year in the past) or a total of 10.6 days per year. This compares to an approximate 21.9 million days per year for the world’s shipping industry. Thus, SURTASS LFA sonar transmissions would make up a very small part of the human-caused sound pollution in the ocean.

Prior to 2017, the Navy has only used SURTASS LFA sonar in the western and central North Pacific Ocean. However, in 2017 the U.S. Navy requested programmatic section 7 consultation for the operation of SURTASS LFA sonar from August 2017 through August 2022 in the non-polar region of the world’s oceans (including within the action area). The consultation was concluded in August 2017 (NMFS 2017e) and considered the Navy’s SURTASS LFA program as well as specific SURTASS LFA operations.

8.16 The Impact of the Environmental Baseline on Endangered Species Act-Listed Species

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed species considered in this consultation. Some of these stressors result in mortality or serious injury to individual animals (e.g., vessel strike, whaling), whereas others result in more indirect (e.g., a fishery that impacts prey availability) or non-lethal impacts (e.g., whale watching). Assessing the aggregate impacts of these stressors on species is difficult and, to our knowledge, no such analysis exists. This becomes even more difficult considering that many of the species in this opinion are wide ranging and subject to stressors in locations throughout the action area and outside the action area.

We consider the best indicator of the aggregate impact of the *Environmental Baseline* on ESA-listed resources to be the status and trends of those species. As noted in section 4, some of the species considered in this consultation are experiencing increases in population abundance, some are declining, and for others, their status remains unknown. Taken together, this indicates that the *Environmental Baseline* is impacting species in different ways. The species experiencing increasing population abundances are doing so despite the potential negative impacts of the *Environmental Baseline*. Therefore, while the *Environmental Baseline* may slow their recovery, recovery is not being prevented. For the species that may be declining in abundance, it is possible that the suite of conditions described in the *Environmental Baseline* is preventing their recovery. However, it is also possible that their populations are at such low levels (e.g., due to historic commercial whaling) that even when the species' primary threats are removed, the species may not be able to achieve recovery. At small population sizes, species may experience phenomena such as demographic stochasticity, inbreeding depression, and Allee effects, among others, that cause their limited population size to become a threat in and of itself. A thorough review of the status and trends of each species is discussed in the *Status of Endangered Species Act-Listed Resources* of this opinion.

9 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. §402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

The jeopardy analysis relies upon the regulatory definition of to "jeopardize the continued existence of a listed species," which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

In Section 5, we identified the following stressors created by the proposed action: pollution, vessel strikes, acoustic and visual disturbance, and entanglement. Here, we describe the probability of individuals of ESA-listed species being exposed to these stressors, and the probable responses of those individuals to the stressors (given probable exposures). In doing so, we take into account the conservation measures described in 3.7. As described in Section 2, for any responses that would be expected to reduce an individual's fitness (i.e., growth, survival, annual reproductive success, or lifetime reproductive success), the assessment would consider the risk posed to the viability of the population(s) those individuals comprise, and to the ESA-listed species those populations represent. We are particularly concerned about behavioral and stress-based physiological disruptions and potential unintentional mortality that may result in animals that fail to feed, reproduce, or survive because these responses are likely to have population-level consequences. The purpose of this assessment and, ultimately, of this consultation is to determine if it is reasonable to expect that the proposed action would have effects on ESA-listed species that could appreciably reduce their likelihood of surviving and recovering in the wild.

9.1 Stressors Not likely to Adversely Affect Endangered Species Act Listed Species

As noted in Section 7.1, if the effects of an action are determined to be wholly beneficial, insignificant, or discountable, we conclude that the action is not likely to adversely affect ESA-listed species. This same concept applies to individual stressors associated with the proposed action, such that some stressors may be determined to be not likely to adversely affect ESA-listed species because any effects associated with the stressors would not rise to the level of take under the ESA. As further detailed below, we find that the stressors of pollution, vessel strikes, acoustic and visual disturbance from vessels and aircraft, acoustic disturbance from echosounders, and entanglement are not likely to adversely affect ESA-listed species because their effects are insignificant or discountable.

9.1.1 Pollution

As noted in Section 5.1, the proposed action may result in pollution from fuel, oil, trash, and other debris (e.g., paper, plastic, wood, glass, and metal associated with galley and offshore food service operations). BOEM has determined that pollution from the proposed seismic surveys is not likely to adversely affect ESA-listed cetaceans and sea turtles (BOEM 2017a).

It is unlikely that pollution resulting from the five proposed surveys would have a measurable impact on ESA-listed cetaceans and sea turtles given the size of the vessels, the amount of fuel, oil, trash, and debris on board, and the various regulations and conservation measures that would minimize and avoid pollution. Oil, fuel, and other vessel-associated chemicals are unlikely to leak or spill into the ocean in volumes that would be expected to have adverse effects to ESA-listed species, as it is imperative to vessel operations that such chemicals remain on board to be used during seismic surveys. An oil or fuel leak would likely pose a significant risk to the vessel and its crew and actions to correct a leak should occur immediately to the extent possible. However, in the event that a leak should occur, the leaked amount of fuel and oil (e.g., 1.2 to 7.1 barrels of diesel fuel; BOEM 2017a) is unlikely to cause widespread, high dose contamination, excluding the remote possibility of severe damage to vessels. We do not anticipate that such discharge would have a measurable impact on ESA-listed cetaceans and sea turtles directly or pose measurable hazards to their food sources. Discharge of trash and debris is prohibited in the ocean unless it is broken up by a comminutor to less than 25 millimeters in diameter (33 C.F.R. §151.51-77). While inadvertent polluting of trash and debris is possible, including lost equipment such as hard hats, gloves, etc., the U.S. Coast Guard and the U.S. Environmental Protection Agency regulations require proactive avoidance of accidental loss of trash and debris (BSEE NTL 2015-G03, Appendix E). Furthermore, as mentioned above, all permits from BOEM would include guidance for handling and disposing of marine trash and debris, similar to BSEE NTL 2015-G03. As a result, the amount of trash and debris that would enter the marine environment as the result of the five proposed seismic surveys is expected to be minimal.

In summary, while some pollution resulting from seismic surveys is possible, the amount of pollution that we expect could occur would not have measurable effects on ESA-listed cetaceans and sea turtles, making its effects insignificant. Therefore, we concur with BOEM that pollution that may result from the five proposed seismic surveys is not likely to adversely affect the ESA-listed cetaceans and sea turtles considered in this opinion.

9.1.2 Vessel Strike

Vessel traffic associated with the proposed action carries the risk of vessel strikes of sea turtles and cetaceans. BOEM has determined that vessel traffic associated with the proposed seismic surveys is not likely to adversely affect ESA-listed cetaceans and sea turtles (BOEM 2017a).

In general, the probability of a vessel collision and the associated response depends, in part, on the size and speed of the vessel. The majority of vessel strikes of large whales occur when vessels are traveling at speeds greater than approximately 10 knots, with faster travel, especially of large vessels (80 m or greater), being more likely to cause serious injury or death (Conn and Silber 2013; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007). Much less is known about vessel strike risk for turtles, but it is considered an important injury and mortality risk within the action area (Lutcavage et al. 1997), particularly in the southern portion of the action area off the coast of Florida (NMFS and USFWS 2008). Based on behavioral observations of turtle avoidance of small vessels, green turtles may be susceptible to vessel strikes at speeds as low as two knots (Hazel et al. 2007). If an animal is struck by a vessel, responses can include death, serious injury, and/or minor, non-lethal injuries, with the associated response depending on the size and speed of the vessel, among other factors (Conn and Silber 2013; Jensen and Silber 2004; Laist et al. 2001; Vanderlaan and Taggart 2007).

While vessel strikes of cetaceans and sea turtles resulting from seismic survey operations are possible, we are not aware of any definitive case of a cetacean or sea turtle being struck by a vessel associated with seismic surveys. In addition, the following aspects of the proposed action decrease the likelihood of a vessel strike associated with seismic survey activities:

1. A maximum of only 16 vessels would be used across all five companies, and the majority of these (support vessels) would be under 80 m (Table 8).
2. During transit, as opposed to during seismic surveys when airguns would be active, all vessels would travel at relatively slow speeds around 12 knots or less and below 10 knots in all SMAs, DMAs, and North Atlantic right whale critical habitat during periods when right whales are anticipated to be present.
3. When conducting seismic surveys (i.e., active airguns), vessels would transit even slower (approximately 4.5 knots) and would be producing airgun sounds that would likely alert animals to the presence of the vessel well before the animals are within striking range such that they may avoid the vessel’s path.

4. During active airgun use, PSOs would be monitoring for cetaceans and sea turtles and thus should be able to inform the vessel operators of the location of the animal to prevent a vessel strike.
5. The proposed time/area closures minimize the overall probability of exposure of several ESA-listed species (e.g., North Atlantic right whales, sea turtles, sperm whales) to vessel traffic. Within these closures, vessel traffic would be restricted to only that needed to transit through the area to reach an area where seismic activity would be conducted.
6. Per the proposed vessel strike avoidance measures (Section 3.7.3), even during transit, observers (e.g., crew) would be required to lookout for and avoid approaching cetaceans and sea turtles.

Table 8. Characteristics of vessels associated with proposed seismic surveys. In some cases, information is based on estimates of typical vessels used. See Section 3 for more details.

Company	Number of Vessels		Length (m)		Cruising/Max Speed (knots)	
	Seismic	Support	Seismic	Support	Seismic	Support
ION	1	1	72.1	37-46	9.5/10	--/12
Spectrum (estimated)	1	1	60-100	35-50	9/12	10/12
TGS	2	2-3	75-85	19-24	--/12	--/12
WesternGeco	1	3	70.5	40-50	9/12	10/12
CGG	1	2	100	50	8/--	10/--

For these reasons, we believe the likelihood of a vessel associated with the five proposed seismic surveys striking an ESA-listed cetacean or sea turtle is extremely low and discountable. Therefore, we concur with BOEM that vessel traffic associated with the five proposed seismic surveys is not likely to adversely affect the ESA-listed cetaceans and sea turtles considered in this opinion.

9.1.3 Vessel Disturbance

Seismic and/or support vessels may cause visual or auditory disturbances to ESA-listed cetaceans and sea turtles and more generally disrupt their behavior. BOEM has determined that any disturbance that may result from vessels associated with the proposed seismic surveys is not likely to adversely affect ESA-listed cetaceans and sea turtles (BOEM 2017a).

Cetacean behavioral responses to vessel disturbance range from little to no observable change in behavior to momentary changes in swimming speed and orientation, diving, surface and foraging behavior, and respiratory patterns, as well as changes in vocalizations (Au and Green 2000; Baker et al. 1983; Baumgartner and Mate 2003; Hall 1982; Isojunno and Miller 2015; Jahoda et al. 2003; Koehler 2006; Lesage et al. 1999; Malme et al. 1983; Richardson et al. 1985; Scheidat et al. 2006; Watkins et al. 1981). Watkins et al. (1981) found that both fin whales and humpback whales appeared to react when approached by small vessels by increasing swim speed, exhibiting a startle reaction and moving away from the vessel with strong fluke motions. In a study on North Atlantic right whales, 71 percent of 42 whales that were closely approached by a research vessel (within 10 m) showed no observable reaction; when reactions occurred, they included lifting of the head or flukes, arching the back, rolling to one side, rolling to one side and beating the flukes, or performing a head lunge (Baumgartner and Mate 2003). In another study on North Atlantic right whales, Nowacek et al. (2004) observed no noticeable behavioral responses to passing vessels nor to simulated vessel sounds. Studies of other baleen whales, specifically bowhead and gray whales, have documented short-term behavioral responses to a variety of actual and simulated vessel activity and sounds (Malme et al. 1983; Richardson 1985). Close approaches by small research vessels caused fin whales (n = 25) in the Ligurian Sea to stop feeding and swim away from the approaching vessel (Jahoda et al. 2003). A study on the effects of research vessel presence on sperm whale behavior found that sperm whales (n = 12) off the coast of Norway spent 34 percent less time at the surface and 60 percent more time in a non-foraging silent active state when in the presence of the vessel than in the post-vessel baseline period, indicating costs in terms of lost feeding opportunities and recovery time at the surface (Isojunno and Miller 2015). Regardless of the response, cetaceans appear to resume species typical behavior within minutes of vessels leaving the area (Au and Green 2000; Baker et al. 1983; Baumgartner and Mate 2003; Hall 1982; Isojunno and Miller 2015; Jahoda et al. 2003; Koehler 2006; Malme et al. 1983; Richardson et al. 1985; Scheidat et al. 2006; Watkins et al. 1981).

The nature of the behavioral response cetaceans exhibit to vessels may depend on vessel speed, size, and distance from the animal, as well as the number and frequency of vessel encounters (Baker et al. 1988; Beale and Monaghan 2004). In addition, characteristics of the individual animal and/or the context of the vessel encounter, including the animal's age and sex, the presence of offspring, whether or not habituation to vessels has occurred, individual differences in reactions to vessels, and the behavioral state of the animal can influence the behavioral response (Baker et al. 1988; Gauthier and Sears 1999; Hooker et al. 2001; Koehler 2006; Lusseau 2004; Richter et al. 2006; Weilgart 2007; Würsig et al. 1998). Observations of large whales indicate that cow-calf pairs, smaller groups, and groups with calves appear to be more responsive to vessels (Bauer 1986; Bauer and Herman 1986; Clapham and Mattila 1993; Hall 1982; Williamson et al. 2016). Reactions to vessel sound by bowhead and gray whales were observed when engines were started at distances of approximately 914 m (Malme et al. 1983; Richardson et al. 1985), suggesting that some level of disturbance may result even if vessels do not come near the animals. It should be noted that human observations of a cetacean's behavioral response may not reflect a whale's actual experience; thus our use of behavioral observations as indicators of a whale's response to vessels may not be correct (Clapham and Mattila 1993).

Much less is known about the physiological responses cetaceans exhibit to vessel disturbance, but based on their behavioral responses and studies of terrestrial species, it is often assumed that they may exhibit a stress related response (Parsons 2012; Wright et al. 2007). We are aware of only one study specifically aimed at examining the physiological responses of cetaceans to vessel disturbance (but see Ayres et al. 2012). Following a decrease in shipping traffic in the Bay of Fundy, Rolland et al. (2012) found that North Atlantic right whales had reduced fecal stress-related hormone metabolites (glucocorticoids), suggesting that despite no overt behavioral response to passing vessels (Nowacek et al. 2004), at least some North Atlantic right whales may exhibit a physiological hormonal response to vessel disturbance.

Potential responses of sea turtles to vessel disturbance, both behavioral and physiological, may be similar to those of cetaceans and may include startle responses, avoidance, other behavioral reaction, and/or a physiological stress response. However, very little research exists on sea turtle responses to vessel disturbance. In fact, in our literature searches we could find no study specifically aimed at quantifying sea turtle response to vessel disturbance. However, a study examining vessel strike risk to green sea turtles suggested that sea turtles may habituate to vessel sound and may be more likely to respond to the sight of a vessel rather than the sound of a vessel, although both may play a role in prompting reactions (Hazel et al. 2007). Regardless of what specific stressor associated with vessels turtles are responding, they only appear to show responses (avoidance behavior) at approximately 10 m or closer (Hazel et al. 2007). Based on this study, and our recent programmatic evaluation of NMFS' scientific research permitting program for ESA-listed turtles, vessels are expect to cause minimal disturbance to sea turtles (NMFS 2017d).

Despite the varied responses to acute vessel disturbance described above, we expect that any vessel disturbance that may result from the proposed seismic surveys would be minimal for many of the same reasons that we find vessel strikes to be extremely unlikely (low vessel activity and mostly small vessels, slow transit speeds, airgun sounds to alert animals of vessel presence, PSO and/or crew monitoring for nearby ESA-listed species, and closures that limit vessel traffic in certain areas at certain times of the year; see 1-6 in Section 9.1.2). In addition, most of the responses noted above are in response to whale watching and/or research vessels, which in contrast to the vessels associated with the proposed action, deliberately approach animals at much closer distances and stay near animals for much longer than would occur under the proposed action. We expect that the vessels associated with the proposed seismic surveys would actively avoid ESA-listed cetaceans and sea turtles due to the proposed vessel strike avoidance measures and the use of PSOs. In fact, an encounter with an ESA-listed cetacean or sea turtle during seismic surveys may necessitate a shutdown, pause, or delay airgun activation, which would ultimately impede the seismic survey operator from obtaining the desired data. As such, any encounters of ESA-listed cetaceans or sea turtle are expected to be brief, as the vessel transits past the animal.

Researchers have noted that the cumulative increase in ambient sound that may result from vessels, particularly large commercial vessels, may hinder communication for some species, including North Atlantic right whales (Cholewiak et al. 2018; Clark et al. 2009; Gabriele et al. 2018; Hatch et al. 2012). Furthermore, vessel sound has been correlated with changes in stress hormones (Rolland et al. 2012) and long and short term changes in vocalizations (Parks et al.

2007a; Parks et al. 2011a; Parks et al. 2012b). We do not expect that the addition of 16 vessels (mostly small vessels, Table 8), spread out over the action area in both space and time, would produce such measurable impacts [although see Gabriele et al. (2018) for how similar vessel activity may affect humpback whale communication in a confined bay]. Any response to vessel noise is expected to be short-term and occur during and/or shortly after any vessel encounter. In fact, even with the additional sound generated by 16 vessels (not including sound from airguns), ambient sound levels in at least some parts of the action area (e.g., off the coast of Georgia), are likely to remain well below that observed at higher latitudes (e.g., Bay of Fundy), where many of the baleen whale species considered in this opinion migrate to feed (Parks et al. 2009).

In summary, considering the proposed conservation measures to minimize and avoid disturbance from vessels, and the level of disturbance that may result from the vessel activity associated with the proposed action, we find that the effects of vessel disturbance on ESA-listed cetaceans and sea turtles are insignificant. While this conclusion is well supported for survey vessels in transit and support vessel operations, it is especially true during active seismic survey operations, since relative to the sound produced by the airgun array, vessel disturbance is expected to be inconsequential. Thus, we concur with BOEM that any disturbance that may result from vessels associated with the proposed seismic surveys, including survey vessel transit and support vessel operations, is not likely to adversely affect ESA-listed cetaceans and sea turtles.

9.1.4 Aircraft Disturbance

Like vessels above, aircraft associated with the proposed seismic surveys may cause visual or auditory disturbances to ESA-listed cetaceans and sea turtles and more generally disrupt their behavior. BOEM has determined that any disturbance that may result from aircraft associated with the proposed seismic surveys will have no effect on ESA-listed cetaceans and sea turtles (BOEM 2017a).

Cetacean responses to aircraft depend on the animals' behavioral state at the time of exposure (e.g., resting, socializing, foraging or traveling) as well as the altitude and lateral distance of the aircraft to the animals (Luksenburg and Parsons 2009). The underwater sound intensity from aircraft is less than produced by vessels, and visually, aircraft are more difficult for whales to locate since they are not in the water and move rapidly (Richter et al. 2006). Thus, when aircraft are at higher altitudes, whales often exhibit no response, but lower flying aircraft (e.g., approximately 500 m or less) have been observed to elicit short-term behavioral responses (Luksenburg and Parsons 2009; NMFS 2017b; NMFS 2017g; Patenaude et al. 2002; Smultea et al. 2008; Würsig et al. 1998). Further, aircraft flying at low altitude, at close lateral distances and above shallow water elicit stronger responses than aircraft flying higher, at greater lateral distances and over deep water (Patenaude et al. 2002; Smultea et al. 2008).

The sensitivity to disturbance by aircraft may also differ among species (Würsig et al. 1998). Sperm whales have been observed to respond to a fixed-wing aircraft circling at altitudes of 245 to 335 m by ceasing forward movement and moving closer together in a parallel flank-to-flank formation, a behavioral response interpreted as an agitation, distress, and/or defense reaction to the circling aircraft (Smultea et al. 2008). Bowhead whales, a relative of North Atlantic right whales, approached during aerial research surveys only occasionally exhibited short-term behavioral reactions to helicopters (14 percent of groups), and most of these reactions occurred at altitudes below or equal to 150 m (Patenaude et al. 2002). In response to fixed-wing aircraft, only 2.2 percent of bowhead whales exhibited a response, and similarly, most of these responses occurred at altitudes below or equal to 182 m (Patenaude et al. 2002). Based on these studies, and our previous consultations on numerous scientific research permits involving aerial surveys (NMFS 2017a; NMFS 2017b; NMFS 2017c; NMFS 2017g), we expect that the ESA-listed cetaceans considered in this opinion may exhibit no response or short-term behavioral responses to overpassing aircraft. To our knowledge, no physiological responses to aircraft have been documented in the literature, but we conservatively assume that a low-level, short-term stress response is possible.

As with vessel disturbance above, little information is available on how ESA-listed sea turtles respond to aircraft, but they do not appear to exhibit a response to unmanned aerial systems (Bevan et al. 2015). For the purposes of this consultation, we assume ESA-listed sea turtles may exhibit similar short-term behavioral responses as described above for cetaceans (e.g., diving, changes in swimming, etc.), which is consistent with those observed during aerial research surveys of sea turtles (NMFS 2017c; NMFS 2017d; NMFS 2017g). As with cetaceans, we are unaware of any data on the physiological responses sea turtles exhibit to aircraft, but we conservatively assume a low-level, short-term stress response is possible.

While the above review indicates that ESA-listed cetaceans and sea turtles may exhibit short-term behavioral and/or stress responses, such responses to aircraft associated with the proposed seismic surveys are expected to be infrequent, minimal, and not result in harassment for several reasons. First, very few aircraft would be used throughout the proposed action. Only TGS has stated that they may use helicopters to support crew changes, but we do not expect this to be frequent as helicopters would only be used when needed (e.g., no suitable port facility is nearby) to support chase vessels. It is possible that the other companies may use helicopters, but we would only expect this to occur in emergencies and in these cases, the U.S. Coast Guard would likely operate the helicopters. Second, any aircraft that would be used would not circle or hover over marine mammals or sea turtles, meaning only a brief exposure is possible. This is in contrast to many of the studies described above that involved circling and hovering, and thus longer exposure. Finally, all helicopters associated with TGS crew changes would fly at an altitude of least 305 m and a radial distance of 500 m from marine mammals. During emergency situations (for TGS, or any company), helicopters may fly at a lower altitude, but BOEM notes that typically, offshore support helicopters fly at altitudes between 229 and 716 m (BOEM 2017a).

In summary, based on data indicating that ESA-listed cetaceans and sea turtles only rarely respond to aircraft, usually at lower altitudes when aircraft are hovering or circling, on the level of aircraft activity associated with the proposed seismic surveys, and on the specific operations of these aircraft (no circling, 305 m altitudes, etc.), we find that the effects of aircraft disturbance on ESA-listed cetaceans and sea turtles are insignificant. While we do not concur with BOEM that any disturbance that may result from aircraft associated with the proposed seismic surveys will have no effect on ESA-listed cetaceans and sea turtles, we do find that any disturbance that may result from aircraft associated with the proposed seismic surveys is not likely to adversely affect ESA-listed cetaceans and sea turtles.

9.1.5 Echosounders

In addition to using seismic airguns, the primary active acoustic source associated with the proposed action, the G&G companies propose to use navigational echosounders and ION proposes to use a low-level acoustic pinger to help position their airgun array and streamer. These types of active acoustic sources may cause auditory disturbances to ESA-listed cetaceans and sea turtles and more generally disrupt their behavior. In extreme circumstances, some echosounders and pingers may also have the potential to cause injury, and some evidence indicates they may play a role in the stranding of certain species of cetacean. However, since the proposed echosounders and pinger would only produce low-level, high frequency sound, they are not expected to overlap and mask the vocalizations of ESA-listed cetaceans. In their APSSI, BOEM did not distinguish between different types of active acoustic sources (e.g., echosounders vs. seismic airguns), but overall determined that active acoustic sources are likely to adversely affect ESA-listed cetaceans but are not likely to adversely affect sea turtles (BOEM 2017a). The Permits and Conservation Division do not propose to authorize take of marine mammals due to the use of echosounders and ION’s proposed pinger, as the use of these active acoustic sources by the five G&G companies is not expected to result in harassment of marine mammals under the MMPA.

Blue, fin, North Atlantic right, sei whales could potentially exhibit a behavioral response to sounds produced by the proposed echosounders and pinger. However, these acoustic sources are expected to be outside the best hearing range of baleen whales (NOAA 2018), so little or no response is expected in most cases. While Todd et al. (1992) found that mysticetes reacted to sonar sounds at 3.5 kHz within the 80 to 90 dB re: 1 μPa range, it is difficult to determine the significance of this because the sound source was a signal designed to be alarming and the sound level was well below typical ambient sound. Goldbogen et al. (2013) found blue whales to respond to 3.5 to 4 kHz mid-frequency sonar at received levels below 90 dB re: 1 μPa. Responses included cessation of foraging, increased swimming speed, and directed travel away from the source (Goldbogen et al. 2013). Maybaum (1990; 1993) observed Hawaiian humpback whales move away and/or increase swimming speed upon exposure to 3.1 to 3.6 kHz sonars. These studies suggest that some baleen whales are able to detect echosounders and furthermore, exhibit a behavioral response. However, the frequencies used in these studies are all below those proposed for use by the G&G companies (where specified), indicating that behavioral responses are unlikely.

The proposed echosounders and pinger have a greater potential to be detected by sperm whales given their assumed hearing range, and the available data somewhat support this. Sperm whales have stopped vocalizing in response to 6 to 13 kHz pingers, but did not respond to 12 kHz echosounders (Backus and Schevill 1966; Watkins 1977; Watkins and Schevill 1975). Sperm whales exhibited a startle response to 10 kHz pulses upon exposure while resting and feeding, but not while traveling (André and Lopez Jurado 1997; André et al. 1997). Given these data, we assume that sperm whales are able to detect echosounders, and some may exhibit a minor behavioral response.

Given what is known about the hearing range of sea turtles, they are not expected to be able to detect the frequencies emitted by the proposed echosounders and pinger (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Lenhardt 2002; Ridgway et al. 1969). Furthermore, we are aware of no data that suggest sea turtles exhibit a behavioral response to exposure of sounds from echosounders. Therefore, ESA-listed sea turtles are expected to exhibit no response if exposed to echosounders.

Based on the above information, sperm whales are the most likely species to exhibit a behavioral response to the proposed echosounders and pinger, but it is possible that baleen whales would also exhibit behavioral responses in some cases. The vast majority of the time echosounders would be in use, so would airguns which have much higher source levels and are expected to cause a more severe behavioral response than any associated with echosounders specifically. Similarly, while unlikely, if baleen whales were to detect echosounders, we would expect that in most cases, any response would be to airguns rather than the echosounder itself. We recognize that there would be limited use of echosounders and the pinger while airguns are not active, for example, when vessels are in transit from port to areas where seismic surveys will occur or when ION is using the pinger to position seismic equipment. However, we do not believe this results in meaningful exposure to ESA-listed cetaceans since, given the lower source levels and higher frequencies of echosounders and pingers, animals would need to be very close to the transducer to receive source levels that would produce a behavioral response (Lurton 2016). Such close proximity between any ESA-listed cetacean and a transducer is extremely unlikely, especially given the vessel strike avoidance measures described in 3.7.3.

In addition to possibly eliciting a behavioral response, it is possible that under extreme circumstances some echosounders and pingers could produce sounds that may result in PTS and TTS. However, TTS and PTS are even less likely than behavioral responses since animals would need to be even closure to the transducer for these to occur. Kremser et al. (2005) concluded the probability of a cetacean swimming through the area of exposure when such sources emit a pulse is small, as the animal would have to pass at close range and be swimming at speeds similar to the vessel in order to receive multiple pulses that might result in sufficient exposure to cause TTS. This finding is further supported by Boebel et al. (2005), who found that even for echosounders with source levels substantially higher than those proposed here, TTS is only possible if animals pass immediately under the transducer. Burkhardt et al. (2013) estimated that the risk of injury from echosounders was less than three percent that of vessel strike, which as noted above in Section 9.1.2 is considered extremely unlikely to occur such that it is discountable. In addition, modelling by Lurton (2016) of multibeam echosounders indicates that the risk of injury from exposure to such sources is negligible.

Finally, there is some evidence to suggest that echosounders and similar acoustic sources such as pingers are involved in the stranding of certain cetacean species. Investigations stemming from a 2008 stranding event in Madagascar indicated a 12 kHz multi-beam echosounder played a significant role in the mass stranding of a large group of melon-headed whales (*Peponocephala electra*) (Southall et al. 2013). Although pathological data indicating a direct physical effect are lacking, and the authors acknowledge that while the use of this type of sonar is widespread and common-place globally without noted incidents (like the Madagascar stranding), all other possibilities were either ruled out or believed to be of much lower likelihood as a cause or contributor to stranding compared to the use of the multi-beam echosounder (Southall et al. 2013). This incident highlights the caution needed when interpreting effects that may or may not stem from anthropogenic sound sources, such as echosounders, since effects are likely to be context specific (Ellison et al. 2012; Ellison et al. 2018). Nonetheless, effects such as this have not been documented for ESA-listed species and are considered extremely unlikely to occur based on the specifications of the proposed echosounders and pinger.

Navigational echosounders are operated routinely by thousands of vessels around the world, and to our knowledge, strandings have not been correlated with their use. Stranding events associated with the operation of naval sonar suggest that mid-frequency sonar sounds may have the capacity to cause serious impacts to marine mammals (Parsons 2017; U.S. Navy 2017b). The echosounders and pinger proposed for use differ from sonars used during naval operations, which generally have higher source levels, lower frequencies, a longer pulse duration, and more horizontal orientation than the more downward-directed echosounders. The sound energy received by any individuals exposed to an echosounder during the proposed seismic survey activities would be much lower relative to naval sonars, as would be the duration of exposure. The area of possible influence for the echosounders is also much smaller, consisting of a narrow zone close to and below the source vessels as described previously for TTS and PTS. Because of these differences, we do not expect the proposed echosounders and pinger to contribute to a marine mammal stranding event.

In summary, given the available data on baleen whales and sea turtles, these species are not expected to exhibit behavioral responses, TTS, or PTS if exposed to the proposed echosounders and pinger. For sperm whales, it is possible that the use of the proposed echosounders and pinger may produce a behavioral response, and if an individual were to travel along with the vessel in very close proximity to the transducer, it could potentially experience TTS and even PTS. However, even for sperm whales the likelihood of such effects are considered extremely low since no ESA-listed species are expected to be this close to any vessel associated with the proposed action given the proposed vessel strike avoidance measures (Section 3.7.3). Finally, based on available data we do not expect the use of the proposed echosounders and pinger to result in a marine mammal stranding event. Therefore, we find that the effects of the proposed echosounders and pinger on ESA-listed cetaceans and sea turtles are extremely unlikely to occur such that it is discountable. Accordingly, we determined that these active acoustic sources are not likely to adversely affect the ESA-listed cetaceans and sea turtles considered in this opinion.

9.1.6 Entanglement

Towed seismic equipment poses a risk of entanglement to ESA-listed cetaceans and sea turtles. BOEM did not specifically address the risk of entanglement in towed seismic equipment in their APSSI (BOEM 2017a).

While it is possible that towed seismic equipment will come into contact with ESA-listed cetaceans, we are not aware of any reports of such interactions and even if such interactions were to occur, we do not anticipate they would result in entanglement for several reasons. The towed equipment is rigid and as such would not encircle, wrap around, or in any other way entangle any of the large whales considered in this opinion. Furthermore, baleen whales, and possibly sperm whales, are expected to avoid areas where airguns are actively being used (see Section 9.2.2), meaning they would also avoid towed seismic equipment. For these reasons, we find it extremely unlikely, and thus discountable, that any of the ESA-listed cetaceans considered in this opinion will become entangled in towed seismic equipment.

Any part of the towed seismic equipment may come into contact with ESA-listed sea turtles, but perhaps the most likely equipment to entangle sea turtles is the streamer tail buoy (Keatos Ecology 2009). Nelms et al. (2016) notes that while they could not find any peer-reviewed literature documenting sea turtle entanglement in seismic equipment, they did receive anecdotal reports of entanglement in tail buoys and airgun strings during seismic surveys off the west coast of Africa, which Weir (2007) also reports on and notes that these incidents were fatal. Keatos Ecology (2009) also notes that turtles have been entangled in seismic equipment off the coasts of India and Australia and in the Gulf of Mexico, with at least some of these resulting in mortality. However, for these incidents they did not specify what equipment caused the entanglements (tail buoys or other towed equipment), so it is unclear how they related to the proposed seismic surveys. A 2011 seismic survey off the coast of Costa Rica recovered a dead olive ridley turtle (*Lepidochelys olivacea*) in the foil of towed seismic equipment, but it was unclear whether the sea turtle became entangled pre- or post mortem (Spring 2011). In contrast to these accounts, there are several observations of sea turtles investigating streamers and not becoming entangled, along with seismic operations occurring in regions of high sea turtle density elsewhere in the world with no entanglements occurring (Hauser et al. 2008; Holst and Smultea 2008; Holst et al. 2005a; Holst et al. 2005b). The likelihood of entanglement may in large part depend on the design of the equipment (e.g., the tail buoy, Keatos Ecology 2009), so it is possible that the contradictory cases mentioned above are the result of differences in equipment used. In particular, the use of properly designed 'turtle guards' that have both a deflector and an exclusion element likely reduce or may even eliminate entanglements in tail buoys (Keatos Ecology 2009).

The above review indicates that ESA-listed sea turtles may become lethally entangled in at least some seismic equipment. There is considerable uncertainty regarding the frequency of such entanglements, as the available data mostly remain anecdotal (Keatos Ecology 2009; Nelms et al. 2016; Weir 2007). However, we are aware of only one report of a turtle becoming entangled in towed seismic gear under BOEM's previous permits to other seismic operators in the Gulf of Mexico based on 15 years of PSO data (Glenn personal communication to E. Patterson on December 7, 2017). The turtle in this particular instance was dead upon observation, but its death could not be confidently attributed to entanglement in the seismic equipment (i.e., it may have already been dead prior to entanglement). Furthermore, during consultation BOEM informed us that the vast majority of G&G companies in the Gulf of Mexico use turtle guards on their streamer tail buoys, and some even use some form of a turtle guard on the airgun array itself (Glenn personal communication to E. Patterson on December 12, 2017). This is perhaps not surprising since if a turtle were to become entangled, it would cost the seismic operator time and money to untangle the turtle and re-survey tracklines where the data have been compromised. Since these turtle guards have been in place, there have been no reports of entangled sea turtles in the Gulf of Mexico.

Since all five G&G companies considered in this consultation are regular operators in the Gulf of Mexico, it is highly likely that they would employ the same equipment and operations as the currently do in there, including any measures to avoid turtle entanglement such as turtle guards or equipment modifications. In fact, in their review of our draft opinion, CGG confirmed that the streamer tail buoys that would be used for their seismic surveys are equipped with turtle guards as described in Keatos Ecology (2009). Furthermore, the level of seismic survey activity in the Gulf of Mexico is much higher than that considered here, and with only one reported entanglement in the Gulf of Mexico in 15 years, the chances that a sea turtle becomes entangled in any of the proposed seismic equipment is extremely low, regardless of whether or not the companies use turtle guards. In summary, we believe that the likelihood of a sea turtle becoming entangled in towed seismic equipment associated with the proposed action is extremely low, and therefore discountable. As such, we find the risk of entanglement in towed seismic equipment associated with the proposed seismic surveys is not likely to adversely affect ESA-listed cetaceans and sea turtles.

9.2 Stressors Likely to Adversely Affect Endangered Species Act Listed Species

The only stressor associated with the proposed action identified as being likely to adversely affect ESA-listed species is sound associated with seismic airguns. Below we detail the anticipated exposure and response of ESA-listed species to sound from seismic airguns, and then given these, analyze the risk they pose to ESA-listed species.

9.2.1 Exposure Analysis

In this section, we quantify the likely exposure of ESA-listed species to sound from seismic airguns. For this consultation, the Permits and Conservation Division and the five G&G companies estimated exposure to seismic airgun sounds that would result in take, as defined under the MMPA, for all cetacean species including those listed under the ESA. BOEM did not estimate exposure or take of ESA-listed cetaceans that would be associated with the use of seismic airguns under these specific five seismic permits. For sea turtles, neither the Permits Division, nor the five G&G companies, nor BOEM estimated exposure or take associated with sounds from seismic airguns.

Under the MMPA, take is defined as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. §1361 et seq.) and further defined by regulation (50 C.F.R. §216.3) as "to harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal. This includes, without limitation, any of the following:

- the collection of dead animals, or parts thereof
- the restraint or detention of a marine mammal, no matter how temporary
- tagging a marine mammal
- the negligent or intentional operation of an aircraft or vessel
- the doing of any other negligent or intentional act which results in disturbing or molesting a marine mammal
- feeding or attempting to feed a marine mammal in the wild"

For purposes of the proposed action, harassment is defined under the MMPA as any act of pursuit, torment, or annoyance which:

- has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or
- has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment). Under NMFS regulation, Level B harassment does not include an act that has the potential to injure a marine mammal or marine mammal stock in the wild.

Under the ESA take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." Harm is defined by regulation (50

C.F.R. §222.102) as "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering." NMFS does not have a regulatory definition of "harass." However, on December 21, 2016, NMFS issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." NMFS' interim ESA harass definition does not perfectly equate to MMPA Level A or Level B harassment, but shares some similarities with both in the use of the terms "injury/injure" and a focus on a disruption of behavior patterns.

For ESA-listed marine mammal species, consultations that involve the Permits and Conservation Division's authorization under the MMPA have historically relied on the MMPA definition of harassment. As a result, Level B harassment has been used in estimating the number of instances of harassment of ESA-listed marine mammals, whereas estimates of Level A harassment have been considered instances of harm and/or injury under the ESA depending on the nature of the effects.

As mentioned earlier in Section 1.1, the history of this consultation pre-dates NMFS' interim ESA harass definition. In fact, the applicants finalized their IHA applications with the Permits and Conservation Division in 2015. As such, all data collection, modeling, and environmental document preparation was completed utilizing the MMPA definition of harass. Given this timing and the complexity associated with modeling exposure estimates of marine mammals, consistent with NMFS' practice in prior consultations that involve authorization under the MMPA, we rely on the MMPA definition of Level B harassment to evaluate whether the proposed action is likely to harass ESA-listed cetaceans and if so, use it to estimate the number of instances of harassment of ESA-listed cetaceans that are likely to occur. Importantly, this is a conservative approach since not all forms of Level B harassment under the MMPA necessarily constitute harassment under the ESA (e.g., NMFS 2017g). As such, for cetaceans we do not distinguish between MMPA Level B harassment and ESA harassment further. However, since no exposure estimates were provided for ESA-listed turtles, we considered NMFS' interim guidance on ESA harass when evaluating whether the proposed activities are likely to harass ESA-listed sea turtle species, and if so, to estimate the number of instances of harassment of ESA-listed sea turtles that are likely to occur. As noted above, historically NMFS has considered MMPA Level A harassment harm and/or injury under the ESA. Consistent with this approach, here we rely on the number of instances of MMPA Level A harassment in estimating the number of instances of harm of ESA-listed cetaceans that are likely to occur.

Level B harassment of marine mammals as applied in this consultation may involve a wide range of behavioral responses including but not limited to avoidance, changes in vocalizations or dive patterns, or disruption of feeding, migrating, or reproductive behaviors. The Level B harassment exposures estimates do not differentiate between the types of potential behavioral responses, nor do they provide information regarding the potential fitness or other biological consequences of the responses on the affected individuals. Therefore, we consider the available scientific evidence to determine the likely nature of the behavioral responses and their potential fitness consequences.

Our exposure analysis relies on two basic components: 1) information on species distribution (i.e., density) within the action area and, 2) information on the level of exposure to sound at which species are likely to be affected (i.e., exhibit some response). Using this information, and information on the proposed seismic surveys (e.g., acoustic source specifications, trackline locations, months of operation, etc.), we then estimate the number of instances in which an ESA-listed species may be exposed to sound fields from airguns that may constitute take. Inherent in this processes, and in any estimation of exposure of animals to anthropogenic stressors, is uncertainty. Multiple sources contribute to the overall uncertainty, but the primary sources are the uncertainty associated with animal density estimates (overall abundance, the temporal and spatial location of animals) and the uncertainty associated with determining the level of exposure at which one expects effects (i.e., threshold). Rather than attempting to quantify all possible uncertainty associated with estimating exposure of ESA-listed species to the proposed action, an impossible task given the multitude of factors involved, during consultation we evaluate the available data and information involved in each step of our analysis, and utilize that which we consider the best available in order to minimize the overall uncertainty associated with our final exposure estimates.

It is important to note that the best available density models used in our exposure analysis are habitat based in that they predict animal distributions based on sighting records and correlated environmental data. As such, they do not necessarily produce overall abundance estimates in line with those given in Section 7.2, which are not spatially explicit. In many cases (e.g., sperm and fin whales), these density models predict much higher abundance estimates than those presented in Section 7.2 since they predict animal distributions well beyond areas that have been surveyed. Given this, it is not always relevant to compare exposure estimates to the abundances given in Section 7.2 since these abundance estimates were not used directly in estimating exposure. Instead, in some cases exposure estimates should be compared to abundance estimates derived from the density models used to estimate exposure (see *Description of Marine Mammals in the Area of the Specified Activity* and Table 4 and its associated description in 82 FR 26244 for further explanation).

As noted in Section 1.1, Spectrum requested to modify their tracklines associated with the proposed IHA and BOEM Permit for their survey on June 4, 2018, after the completion of our effects analysis. As such, the analysis below relies primarily on the tracklines provided in the original proposed IHA and BOEM permit for Spectrum, not the modified tracklines. However, changes in exposure that may result from Spectrum's modified tracklines are fully considered in Section 9.3 below and the *Incidental Take Statement* of this opinion in Section 13.

9.2.1.1 Cetaceans

In their IHA applications, the five G&G companies estimated exposure of ESA-listed cetaceans to seismic airguns according to the MMPA definition of take, including that of harassment. In addition, the Permits and Conservation Division conducted their own cetacean exposure analysis based on the information provided by the applicants, comments received during the public comment period that was required on the proposed IHAs, and any additional available information relevant to the exposure of cetaceans to the proposed seismic surveys.

For our ESA section 7 consultation, we evaluated both the applicants' and the Permit and Conservation Division's exposure estimates of the number of ESA-listed cetaceans that would be "taken" relative to the definition of MMPA Level A and Level B harassment, which we have adopted to evaluate harm and harassment of ESA-listed cetaceans in this consultation respectively. Furthermore, during consultation we worked with the Permits and Conservation Division to revise their exposure estimates to incorporate more recent data on North Atlantic right whales and to account for the proposed closures, which for most species should reduce the overall exposure as compared to that originally proposed by the Permits and Conservation Division in their proposed IHAs. Following this, we adopted the NMFS Permits and Conservation Division's analysis because, after our independent review, we determined it utilized the best available information and methods to evaluate exposure to ESA-listed cetaceans. Below we describe the Permits and Conservation Division's exposure analysis for ESA-listed cetaceans.

Acoustic Thresholds

To determine at what point during exposure to seismic airgun arrays (and other acoustic sources) marine mammals are considered "harassed" under the MMPA, NMFS applies certain acoustic thresholds. These thresholds are used in the development radii for exclusion zones around a sound source and the necessary mitigation requirements necessary to limit marine mammal exposure to harmful levels of sound (NOAA 2018). For Level B harassment under the MMPA, NMFS has historically relied on an acoustic threshold of 160 dB re: 1 µPa (rms). This value is based on observations of behavioral responses of mysticetes (Malme et al. 1983; Malme et al. 1984; Richardson et al. 1986; Richardson et al. 1990), but is used for all marine mammal species. For the proposed action, the Permits and Conservation Division continued to rely on this historic NMFS threshold to estimate the number of Level B takes of ESA-listed cetaceans that they propose to authorize in the five IHAs.

For physiological responses to active acoustics, such as TTS and PTS, the Permits and Conservation Division relied on NMFS' recently issued technical guidance for auditory injury of marine mammals (NOAA 2018)[16]. Unlike NMFS 160 dB re: 1 µPa (rms) Level B threshold, these TTS and PTS auditory thresholds differ by species hearing group (Table 9). Furthermore, these thresholds are a dual metric for impulsive sounds, with one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the duration of exposure, and another based on cumulative sound exposure level (SEL_{cum}) that does incorporate exposure duration. The two metrics also differ in regard to considering information on species hearing. The cumulative sound exposure criteria incorporate auditory weighting functions, which estimate a species group's hearing sensitivity, and thus susceptibility to TTS and PTS, over the exposed frequency range, whereas peak sound exposure level criteria do not incorporate any frequency dependent auditory weighting functions. The metric that results in a largest distance from the source (i.e., produces a largest field of exposure) is used in estimating exposure, since it is the more precautionary criteria.

In using these thresholds to estimate the number of individuals that may experience auditory injury, the Permits and Conservation Division classify any exposure equal to or above the threshold for the onset of PTS as auditory injury, and thus Level A harassment. Any exposure below the threshold for the onset of PTS, but equal to or above the 160 dB re: 1 µPa (rms) threshold is classified as Level B harassment. Among Level B exposures, the Permits and Conservation Division does not distinguish between those individuals that are expected to experience TTS and those that would only exhibit a behavioral response.

Table 9. Impulsive acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for the marine mammal species groups considered in this opinion (NOAA 2018).

Hearing Group	Generalized Hearing Range[17]	Permanent Threshold Shift Onset[18]	Temporary Threshold Shift Onset
Low-Frequency Cetaceans (LF: baleen whales)	7 Hz to 35 kHz	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{pk,flat}$: 213 dB $L_{E,LF,24h}$: 168 dB
Mid-Frequency Cetaceans (MF: sperm whales)	150 Hz to 160 kHz	$L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	$L_{pk,flat}$: 224 dB $L_{E,MF,24h}$: 170 dB

Using the above thresholds, the Permits and Conservation Division evaluated the marine mammal exposure and take estimates associated with seismic airgun sounds provided by the five G&G companies and made several adjustments as described below.

[16] See www.nmfs.noaa.gov/pr/acoustics/guidelines.htm for more information.
[17] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on approximately 65 dB threshold from normalized composite audiogram, with the exception for lower limits for LF cetaceans (Southall et al. 2007).
[18] $L_{pk,flat}$: unweighted ($_{flat}$) peak sound pressure level (L_{pk}) with a reference value of 1 µPa; $L_{E,XF,24h}$: weighted (by species group; $_{LF}$: Low Frequency, or $_{MF}$: Mid-Frequency) cumulative sound exposure level (L_E) with a reference value of 1 µPa^2-s and a recommended accumulation period of 24 hours ($_{24h}$)

Level B Exposure Estimates

For Level B exposure, the applicants utilized the same 160 dB re: 1 µPa (rms) threshold for behavioral harassment under the MMPA as is proposed for use by the Permits and Conservation Division. As such, the Permits and Conservation Division directly evaluated the requested Level B take to inform their take authorizations in the proposed IHAs. To estimate the number of instances of Level B harassment of cetaceans, all five G&G companies took a similar approach which consists of first, modeling sound fields based on some specified acoustic source and environmental parameters, and second, estimating exposure of cetaceans to these sound fields utilizing information on cetacean distributions and in some cases, their movement.

To estimate sound fields generated by the airgun array sources, three of the companies (TGS, CGG, and WesternGeco) directly relied on the results of sound field modeling performed in BOEM's 2014 PEIS, which utilized a 5,400 in^3 airgun array as a representative example [see Appendix D, Figure D-6 in BOEM (2014a) and see Table 1 for how this array compares to those proposed by the five G&G companies]. In adopting these modelling efforts, TGS, CGG, and WesternGeco utilized annual average data, as their survey design did not rely on surveys being conducted at any particular time of the year. Spectrum and ION elected to perform their own sound field modeling based on their specific airgun characteristics and survey designs, including the time of year for which their seismic surveys are proposed (i.e., operating window; February through July for Spectrum, July through December for ION). The sound field models used by the five G&G companies are generally similar in that they attempt to estimate a three-dimensional acoustic propagation field as a function of source characteristics and physical properties of the ocean environment (e.g., depth, temperature, salinity, etc.). Based on the model results, distances to the 160 dB re: 1 µPa (rms) threshold level were calculated for a variety of different environmental conditions (e.g., location, depth, season, etc.).

Using these distances, the five G&G companies then estimate the number of instances in which a cetacean would be exposed to sound fields at or above the 160 dB re: 1 µPa (rms) threshold using either Marine Acoustics, Inc.'s Acoustic Integration Model (Spectrum, ION), the Mysticetus software (Mysticetus LLC: TGS and WesternGeco), or an alternative method similar to our sea turtle exposure analysis described below in Section 9.2.1.2 (CGG) (see section *Description of Exposure Estimates* in 82 FR 26244 and the individual IHA applications for further details on these different exposure modeling methods). In general, all these exposure methods utilize information on sound fields estimated through the acoustic propagation modeling mentioned above combined with information on cetacean densities and in some cases, marine mammal movement and behavior, to estimate the number of Level B takes that may result from the proposed seismic surveys.

At the time four of the G&G companies were initially preparing their IHA applications (ION, Spectrum, WesternGeco, and TGS), the best available information concerning cetacean densities in the U.S. EEZ came from the U.S. Navy's Operating Area Density Estimates (NODEs) (U.S.

Navy 2007). However, a more recent cetacean density modeling effort funded by the U.S. Navy and NOAA was underway (described in Roberts et al. 2016), which incorporated additional data, utilized more advanced statistical modeling, and corrected for several known biases of NODEs. As the Permits and Conservation Division considered these a vast improvement over the NODEs dataset, they worked with Roberts et al. to make the model outputs available to the companies for use in their IHA applications. TGS and WesternGeco elected to use the Roberts et al. (2016) model outputs and revised their Level B exposure estimates accordingly. Since CGG developed their Level B exposure estimates after the Roberts et al. (2016) model outputs were available, they too relied on these for their IHA application. However, Spectrum and ION chose to not incorporate the updated Roberts et al. (2016) models. Instead, because the Permits and Conservation Division determined these new density estimates to be the best available data for most cetacean species, they worked directly with Marine Acoustics, Inc., which performed the original exposure analyses for ION and Spectrum, to update ION and Spectrum exposure estimates based on Roberts et al. (2016). As was done with the original NODEs data, and by the companies that incorporated the Roberts et al. (2016) data directly, they adopted a nearest neighbor[19] approach to extend the Roberts et al. (2016) model to waters beyond the U.S. EEZ within the action area.

For several cetacean species, the Permits and Conservation Division and the G&G companies opted not to rely on the Roberts et al. (2016) models due to these species rarity within the area modelled and because very few data were used to derive these species models. Among these were ESA-listed blue and sei whales. For these species, it was assumed that each company may encounter these species on a single occasion and that the number of individuals encountered would be equal to the species average group size. Thus, for each company, the estimated exposure, and thus proposed Level B take, for blue and sei whales are equal to the species-specific group sizes of one blue whale and two sei whales.

For fin, North Atlantic right [originally, but see below for updates based on Roberts et al. (2017)], and sperm whales, the Permits and Conservation considered the Roberts et al. (2016) model outputs to be the best available data within the action area, given that of all available density estimates, they rely on the greatest amount of data and cover the greatest extent of the action area. Consequently, they relied on these data to estimate Level B exposure as specified above when working with Marine Acoustics, Inc. to update Spectrum and ION's Level B exposure estimates. Similarly, CGG directly relied on the Roberts et al. (2016) model outputs to estimate fin, North Atlantic right, and sperm whale Level B exposure. TGS and WesternGeco, however, only relied on the Roberts et al. (2016) model outputs for North Atlantic right and sperm whales. For fin whales, Smultea Environmental Sciences, LLC, which performed the exposure analyses for both TGS and WesternGeco, opted to derive their own density estimates

[19] In the nearest neighbor approach, areas with unknown density estimates adopt the density estimate from the closest area (adjacent) with a density estimate.

using more recent shipboard and aerial survey data from NMFS Atlantic Marine Assessment Program for Protected Species (AMAPPs), which are not included in the Roberts et al. (2016) models. The Permits and Conservation Division evaluated this approach and determined it to be an acceptable alternative. We agree and also recognize that no one model or approach will always be the most appropriate for all circumstances (Box 1979).

The above exposure analyses were performed prior to the initiation of consultation and were used to inform the proposed authorized Level B take specified in the proposed IHAs (Table 11 in 82 FR 26244). However, during consultation we worked with the Permits and Conservation Division to revise the exposure estimates, and thus the proposed authorized Level B take, to 1) incorporate updated density models for North Atlantic right whales, and 2) account for the proposed closures. While other proposed conservation measures (e.g., shutdowns and ramp-up) are considered important and effective in minimizing the effects of the action, they were not accounted for in estimating exposure since they are not necessarily anticipated to reduce the instances of exposure, but rather the duration of exposure. For example, if a PSO observes a cetacean in the exclusion zone and subsequently a shutdown occurs, the observed animal will have already been exposed to sound levels above 160 dB re: 1 µPa (rms), and thus taken. However, the shutdown would minimize the duration of such exposure. Similarly, ramp-up is not expected to result in a decrease in the overall instances of Level B harassment, since ramp-up is designed to alert animals the presence of the active acoustic source so that they can avoid exposure at higher sound levels that may cause auditory injury and/or more severe behavioral reactions (Stone et al. 2017a). Avoidance responses to ramp-up may very well still constitute Level B harassment, depending the sound level received and the nature of the response.

As noted above in Section 3.7.1.1, during consultation we became aware of an effort by Roberts et al. to update the North Atlantic right whale density models (Roberts et al. 2017). These updated models utilized the same methodology as the Roberts et al. (2016) models but greatly expanded the dataset used to derive density outputs, especially within the action area, since they incorporated both AMAPPs surveys as well as aerial surveys conducted by several organizations in the southeastern portion of the action area. With these additional data sources, the number of North Atlantic right whale sightings used to inform the models within the action area increased by approximately 2,500, with the 2017 models including approximately 72 times as many sightings within the action area as the 2016 models. In addition, these models incorporated several improvements to minimize known biases and used an improved seasonal definition that more closely aligns with right whale biology. While the Roberts et al. (2017) North Atlantic right whale models have not yet undergone peer-review, they rely on the same peer-reviewed statistical approaches as the published Roberts et al. (2016) models and improve on the 2016 models in many ways, especially within the action area. For these reasons, we and the Permits and Conservation Division determined that for North Atlantic right whales, the updated Roberts et al. (2017) model outputs constitute the best available science on North Atlantic right whale density within the action area when compared to all other density estimates for North Atlantic within the action area, including those estimated by the Roberts et al. (2016) models.

Using the Roberts et al. (2017) model outputs, which were provided to us by Roberts et al. on December 6, 2017, we worked with the Permits Division to re-estimate Level B exposure of North Atlantic right whales. To do so, we relied on the acoustic propagation modeling results provided in BOEM's 2014 PEIS [see Appendix D in BOEM (2014a)], as was previously done by TGS, CGG, and WesternGeco in their IHA applications. Using site and season specific radii to the 160 dB re: 1 μPa (rms) threshold (95 percent range, see Appendix D, Table D-22 in BOEM (2014a)], and the total amount of trackline proposed by each company within the acoustic modeling regions specified in BOEM's 2014 PEIS (see Appendix E, Table E-5 and Figures E-11 to E14 in BOEM (2014a)], we calculated monthly, region specific ensonified areas for each company as if their entire survey tracklines were completed in each month. Then, using the updated Roberts et al. (2017) density model outputs, we calculated average monthly regional North Atlantic right whale densities, which were then multiplied by the monthly ensonified areas. Finally, these data were averaged (annually across all months for TGS, CGG, and WesternGeco, and according to the proposed operating windows for Spectrum and ION) to estimate the average total Level B exposure of North Atlantic right whales. In this way, we incorporated the seasonal variation in density of right whales since we do not know the exact distribution of survey effort within each company's operating window. Importantly, in these calculations we took into account all the proposed time-area closures specified in Section 3.7.1. In the year-round closure areas, data (i.e., ensonified areas and North Atlantic right whale densities) were not used to formulate Level B exposure estimates since seismic surveys would be completely prohibited within these areas. In the seasonal closure areas, only data from months when the seasonal closures were open were used in calculating the final Level B exposure estimates. The final resulting Level B exposure estimates then are based on the best available information on North Atlantic right whale densities within the action area from Roberts et al. (2017), fully take into account all proposed time-area closures specified in Section 3.7.1, and are specific to each company's tracklines and proposed operating window (if specified).

In addition to providing updated model outputs for North Atlantic right whales, Roberts et al. (2017) presented updated models for fin, sei, and sperm whales, as well as several other non-ESA-listed cetaceans. While these models incorporate several improvements (additional data, although mostly outside of the action area, new seasonal definitions, better corrections for known biases), the model outputs were generally similar to those produced by the 2016 effort. In fact, in some cases the updated 2017 model outputs did not appear to be statistically significantly different from the 2016 model outputs. Thus, while the Roberts et al. (2017) model outputs for fin, sei, and sperm whales within the action area likely represent minor improvements over the Roberts et al. (2016) model outputs for these species within the action area, they are unlikely to result in meaningful differences if used in an exposure analysis. That is, at this time we and the Permits and Conservation Division consider both the Roberts et al. (2016) and Roberts et al.

(2017) model outputs the best available density estimates for fin, sei, and sperm whales within the action area and estimates of exposure based on the outputs of one model are unlikely to be meaningfully different than estimates based on outputs from other. Given this, we and the Permits and Conservation Division did not request the Roberts et al. (2017) updated fin, sei, and sperm whale model outputs.

However, we did work with the Permits and Conservation Division to adjust the previous exposure estimates for fin and sperm whales to account for the proposed time-area closures specified in Section 3.7.1 (no change was made to blue and sei whales since for these species a single group exposure per company is assumed). In doing so, we relied on the previously estimated exposure, not the proposed authorize take (i.e., Table 10 not Table 11 in 82 FR 26244), because the later was originally limited to approximately 30 percent of the estimated population abundance, a limitation the Permits and Conservation re-evaluated during consultation (see final IHAs for further details). To account for the proposed closures for fin and sperm whales, we took an approach related to that previously described for right whales. In brief, we started with the existing Level B exposure estimates specified in the proposed IHAs and then calculated the Level B exposure that would be avoided due to the proposed closures. We then subtracted this from the original Level B exposure estimates to get our final exposure estimates. However, we took a slightly different approach for each species, given that some of the proposed closures were designed specifically to protect sperm whales, but none was designed specifically to protect fin whales.

For sperm whales, we calculated the monthly density within each year-round closure area using the Roberts et al. (2016) model outputs and calculated the monthly ensonified area within each year-round closure for each company based on their proposed tracklines and the radii to the 160 dB re: 1 µPa (rms) threshold (95 percent range, see Appendix D, Table D-22 in BOEM (2014a)]. We then multiplied the monthly density estimates by the monthly ensonified areas to estimate the monthly Level B exposure avoided, and finally, computed the annual average of these avoided exposures to estimate the overall Level B exposure that would be avoided due to the proposed year-round closures. For the seasonal closures, only the Hatteras and North Closure was accounted for since it is the only seasonal closure designed specifically to protect sperm whales. While we considered accounting for the Maryland (Spectrum only) and the North Atlantic right whale seasonal closures, we opted not to since these closures primarily protect shallower waters where sperm whales are less likely to be found, and the added complication of incorporating these seasonal closures was unlikely to result in meaningful changes to the overall Level B exposure for sperm whale. To account for the Hatteras and North Closure, we calculated the change in Level B exposure due to the closure in a similar fashion to the year-round closures above, except that instead of calculating the change in Level B exposure based on an annual average, we calculated the difference between the average Level B exposure for when the closure was open and when the closure was closed in order to calculate the overall change in Level B exposure due to restricting surveys within this closure to a specific season. As before, for these calculations we took into account the specific timing proposed by Spectrum and ION but assumed surveys for the other companies could happen at any time of the year. The combined year-round and seasonal avoided Level B exposures were then subtracted from the original Level B exposure estimates detailed in the proposed IHAs (Table 10 in 82 FR 26244) to calculate the final estimated Level B exposure for sperm whales.

Given that none of the proposed time-area closures was designed to provide protection for fin whales, a simpler approach was taken to account for the proposed time-area closures in our revised Level B exposure estimates. First, we did not account for any seasonal closures since all were designed to protect other species and are not expected to be particularly beneficial fin whales. Second, in accounting for the proposed year-round closures, we did not calculate density estimates specifically within these closures. Instead, we relied on monthly density estimates originally derived from the Roberts et al. (2016) model outputs, but averaged to each acoustic modelling region used in BOEM's 2014 PEIS. This simpler approach was taken because calculating closure specific densities for fin whales added unnecessary complication to the analysis given that none of the closures was specifically designed to protect fin whales. Using these regional fin whale density estimates, we then followed the same procedure detailed above for sperm whales (multiplied monthly densities by monthly ensonified area, and computed annual or operating window averages) to estimate the fin whale Level B exposure that would be avoided due to the proposed year-round closures. These avoided exposures were then subtracted from the original Level B exposure estimates in the proposed IHAs (Table 10 in 82 FR 26244) to calculate the final estimated Level B exposure for fin whales.

The final estimated exposures of ESA-listed cetaceans to airgun sounds at or exceeding 160 dB re: 1 µPa (rms), and thus considered to be takes by Level B harassment under the MMPA and for the purposes of this consultation takes by harassment under the ESA, are shown below in Table 10. Conservatively, we rounded up North Atlantic right whale exposure estimates and for the remaining species, rounded down any reduction in exposure that resulted from the proposed time-area closures (i.e., assumed less take was avoided). Based on data from the North Atlantic Right Whale Consortium Database provided by T. Gowan (Gowan personal communication to E. Patterson on November 8, 2017), consisting of standardized sighting records of North Atlantic right whales from 2005 to 2013 from South Carolina to Florida, of the total 23 exposures of North Atlantic right whales, we expect four to be of adult females with calves, two to be of adult females without calves, five to be of adult males, 11 to be of juveniles (either sex), three to be of calves (either sex), one to be of an adult of unknown sex, and two to be of animals of unknown age and sex (age class estimates sum to greater than 23 due to conservative rounding up). For the remaining species, we currently lack sufficient information to determine the age-sex class the Level B exposures in Table 10 represent. As such, we assume that the below Level B exposures may be of any age-sex class of sei, fin, blue, and sperm whale.

Table 10. Estimated Level B (Behavioral Harassment and Temporary Hearing Threshold Shifts) exposure of cetaceans to seismic survey sound fields.

Species	ION (July - December)	Spectrum (February - July)	TGS (Year-round)	WesternGeco (Year-round)	CGG (Year-round)	Total
North Atlantic right whale	2	6	9	4	2	23
Sei whale	2	2	2	2	2	10
Fin whale	3	333	1,140	537	45	2,058
Blue whale	1	1	1	1	1	5
Sperm whale	16	1,077	3,579	1,941	1,304	7,917

The number of exposures presented in Table 10 represent the estimated number of instantaneous moments in which an individual from each species would be exposed to sound fields from seismic surveys at or above the 160 dB re: 1 μPa (rms) threshold. They do not necessarily represent the estimated number of individuals of each species that would be exposed, nor do they provide information on the duration of the exposure. That said, when the estimated exposure numbers are low compared to the population abundance, the likelihood that any individual of a given species is exposed more than once is low due to the movement of both the seismic vessels and the animals themselves. Based on this assumption, we believe that the exposure estimates of North Atlantic right, sei, and blue whales likely represent individual animals and assume that individual North Atlantic right, sei, and blue whales are not exposed more than once across all IHAs/permits.

For fin and sperm whales, given the larger exposure estimates across all companies, we assume that some individuals may be exposed more than once meaning the exposures given in Table 10 over estimate the number of individual sperm and fin whales that would be exposed. In fact, for TGS alone we expect there to be repeat exposures of fin and sperm whales based on their large number of exposures. For example, based on the amount of overlap among TGS's proposed tracklines (84 percent overlap), the Permits and Conservation Division estimate that 2,076 individual sperm whales and 664 individual fin whales would be exposed, and of those, 1,503 sperm whales and 480 fin whales would experience two exposures each and 573 sperm whales and 184 fin whales would only be exposed once. As for the duration of each instance of exposure estimated in Table 10, we were unable to produce estimates specific to the proposed action due to the temporal and spatial uncertainty of seismic vessels and cetaceans within the action area. However, given the constant movement of seismic vessels and animals, all the exposures presented in Table 10 are expected to be less than a single day in duration. Furthermore, based on modelling of seismic activity in the Gulf of Mexico, we assume that most instances of exposure would only last for a few minutes (BOEM 2017b, Appendix D Table 26-27: 24-h 160 dB rms SPL estimates). This may be especially true for migrating animals since they are only expected to be exposed for very brief periods given the constant movement of both whales and vessels (Costa et al. 2016a). Nonetheless, if a migrating whale were to travel in the same direction as an active seismic vessel, exposure could be longer.

Level A Exposure Estimates

For Level A harassment (i.e., auditory injury/harm), which we consider harm under the ESA, the Permits and Conservation Division independently estimated exposure since at the time the applicants submitted their IHA applications, NMFS' technical guidance for auditory injury of marine mammals had not been issued. To do this, the Permits and Conservation Division relied on information provided in BOEM's 2014 PEIS (BOEM 2014a) that provided a means to estimate Level A exposure based on the criteria identified in Southall et al. (2007), and then corrected these estimates to align with NMFS' new technical guidance (NOAA 2018). Details on this process can be found in the Federal Register Notice associated with the proposed IHAs in the section entitled *Level A Harassment* (82 FR 26244).

Based on this initial analysis, the only ESA-listed species for which the Permits and Conservation Division originally proposed Level A exposure was the sperm whale (82 FR 26244). However, during consultation, the Permits and Conservation Division re-evaluated their initial Level A exposure analysis, and on based public comment and the estimated amount of Level B exposure for fin whales, they determined that a small subset of the Level B exposures of fin whales should actually be considered Level A exposure. No other Level A exposures of ESA-listed cetaceans are expected or proposed for authorization based on the Permits and Conservation Division's initial exposure analysis and their subsequent re-evaluation of that analysis during consultation.

We evaluated the proposed sperm and fin whale Level A exposures and further considered the likelihood that any individual sperm or fin whale would be exposed to sound levels that may result in sound-induced hearing loss. To do this, we first estimated the distances to the new NMFS' acoustic thresholds based on the acoustic characteristics of the proposed seismic airgun arrays, and then assessed the likelihood that individual sperm and fin whales would come to within or closer than these distances. Using the thresholds identified in Table 9, representative airgun spectrum data (in 1 Hz bands, same data discussed by the Permits and Conservation Division in *Level A Harassment* in 82 FR 26244), array characteristics specified by the applicants, and assuming a point source (as was done by the applicants), spherical spreading, a 4.5 knot transit speed (similar to the proposed vessel speeds), a representative airgun pulse duration of 100 milliseconds (BOEM 2017b; NMFS 2018), and the safe distance methodology proposed by Sivle et al. (2014), we calculated the distance from each array to the point at which each threshold was met. Results from these calculations can be seen in Table 11. Given that dual metric thresholds were used (i.e., 0-pk or SEL_{cum}), we present the distances to both metrics for comparison but conservatively rely on the larger distances for determining exposure (bold numbers in Table 11). While our focus for this analysis was on PTS exposures, we also present distances to the TTS thresholds as they inform our understanding of whether or not the exposures considered above in the *Level B Exposure Estimates* section involve TTS.

Since many of the distances to the various thresholds were quite small, we also estimated the longest dimension of each array based on the proposed dimensions (i.e., the diagonal) and the maximum distance to the near-field. Typically, source levels provided for airgun arrays assume a directional point source, an assumption that is valid only at distances relatively far from the source (i.e., within the far-field) (MacGillivray 2006). Close to the source (i.e., within the near-field) this assumption breaks down as the array consists of multiple acoustic elements (airguns) and the full estimated source level is never realized since the elements do not add coherently (BOEM 2014a; Lurton 2002; Lurton 2010). In general, the near-field for seismic airgun arrays is considered to extend out to at least 250 m (Caldwell and Dragoset 2000). However, for a particular array one can estimate the distance at which the near-field transitions to the far-field, called the *Fresnel distance*, by:

$$D_F = \frac{L^2}{4\lambda}$$

with the condition that $D_F >> \lambda$, and where D_F is the *Fresnel distance*, L is the longest dimension of the array, and λ is the wavelength of the signal (Lurton 2002; Lurton 2010). Given that λ can be defined by:

$$\lambda = \frac{v}{f}$$

where f is the frequency of the sound signal and v is the speed of the sound in the medium of interest, one can rewrite the equation for D_F as:

$$D_F = \frac{fL^2}{4v}$$

and calculate D_F directly given a particular frequency and known speed of sound (here assumed to be 1,500 m per second in water, although this varies with environmental conditions).

To determine the closest distance to the arrays at which the source level predictions in Table 1 are valid (i.e., maximum extent of the near-field), we calculated D_F using a frequency of 1 kHz, a frequency commonly used in such near-field calculations for seismic airgun arrays (BOEM 2014a; MacGillivray 2006; NSF and USGS 2011). Based on the representative airgun spectrum data mentioned above and on field measurements of the seismic airgun array used by the National Science Foundation on their R/V *Marcus G. Langseth*, nearly all (greater than 95 percent) of the energy from seismic airgun arrays is below 1 kHz (Tolstoy et al. 2009). Thus, using 1 kHz as the upper cut-off for calculating the maximum extent of the near-field should reasonably represent the near-field extent in field conditions.

Table 11. Distance to low (fin whales) and mid (sperm whales) frequency cetacean acoustic thresholds for permanent and temporary threshold shifts (PTS and TTS). Bolded values indicate which threshold was for exposure estimates since it resulted in the greatest distance. NA indicates not applicable since the source level is not great enough to produce levels exceeding the specified threshold shift.

Company	Low Frequency Cetaceans				Mid Frequency Cetaceans				Longest Dimension of Array (m)	Maximum Near Field at (m)
	PTS		TTS		PTS		TTS			
	Distance (m) to $L_{E,LF,24h}$: 183 dB	Distance (m) to $L_{pk,flat}$: 219 dB	Distance (m) to $L_{E,LF,24h}$: 168 dB	Distance (m) to $L_{pk,flat}$: 213 dB	Distance (m) to $L_{E,MF,24h}$: 185 dB	Distance (m) to $L_{pk,flat}$: 230 dB	Distance (m) to $L_{E,MF,24h}$: 170 dB	Distance (m) to $L_{pk,flat}$: 224 dB		
ION	**959.1**	79.4	**30,328.8**	158.5	0.0	**22.4**	0.4	**44.7**	37.4	233.1
Spectrum	**763.6**	223.9	**24,148.3**	446.7	0.0	**63.1**	0.3	**125.9**	50.0	416.7
TGS	**382.7**	63.1	**12,102.8**	125.9	0.0	**17.8**	0.2	**35.5**	29.2	142.1
WesternGeco	**80.7**	70.8	**2,551.5**	141.3	0.0	**20.0**	0.0	**39.8**	21.9[20]	79.9
CGG	**763.6**	50.1	**24,148.3**	100.0	0.0	**14.1**	0.3	**28.2**	29.1	141.1
BOEM 5,300 in^3 Large Array[21]	**55.0**	25.1	**1,738.5**	50.1	0.0	**7.1**	0.0	**14.1**	21.9	79.9
BOEM 90 in^3 Small Array[22]	0.9	**4.0**	**27.6**	7.9	0.0	**1.1**	0.0	**2.2**	NA	NA
Small airgun[23]	0.3	**1.1**	**8.7**	2.2	0.0	NA	0.0	NA	NA	NA
Large airgun[23]	**8.7**	6.3	**275.5**	12.6	0.0	**1.8**	0.0	**3.5**	NA	NA

[20] WesternGeco did not specify the dimensions of their array but given that they relied on the representative airgun array used in BOEM (2014a) for the acoustic modeling, we relied on the value for *L* specified in BOEM (2014a).

[21] Calculations based on large array source levels from BOEM (2014a) provided for comparison. See Table 1 above for source characteristics.

[22] Calculations based on 90 in^3 array source levels from BOEM (2014a) provided for comparison. See Appendix D, Table D-5 in BOEM (2014a) for source characteristics.

[23] Calculations based on individual airgun source levels from BOEM (2014a). See Appendix D, page in D-12, in BOEM (2014a) for source characteristics.

If the largest distance to any particular threshold is equal to or less than the longest dimension of the array (i.e., under the array), or within the near-field, then received levels that meet or exceed the threshold in most cases are not expected to occur. This is because within the near-field and within the dimensions of the array, the source levels specified in Table 1 are overestimated and not applicable. In fact, until one reaches a distance of approximately three or four times the *Fresnel distance* the average intensity of sound at any given distance from the array is still less than that based on calculations that assume a directional point source (Lurton 2002; Lurton 2010). Given this, using the distance to the maximum extent of the near-field as the cut-off for where sound levels are considered lower than the estimated source level based on the directional point source assumption is a conservative approach since even beyond this distance the acoustic modelling still overestimates the source level that animals would actually receive. For example, the seismic airgun array used on R/V *Marcus G. Langseth* has an approximate diagonal of 29 m, resulting in *Fresnel distance* of 140 m at 1 kHz (NSF and USGS 2011). Field measurements of this array indicate that the source behaves like multiple discrete sources, rather than a directional point source, beginning at approximately 400 m (deep site) to 1 km (shallow site) from the center of the array (Tolstoy et al. 2009), distances that are actually greater than four times the 140 m *Fresnel distance* calculated for this array. Within these distances, the recorded received levels were always lower than would be predicted based on calculations that assume a directional point source, and increasingly so as one moves closer towards the array (Tolstoy et al. 2009).

Within the near-field, in order to explicitly evaluate the likelihood of exceeding any particular acoustic threshold, one would need to consider the exact position of the animal, its relationship to individual airguns, and how the individual acoustic sources propagate and their acoustic fields interact. While in some cases received levels at or in excess of a particular threshold may be possible, we find this highly unlikely for two reasons. First, we do not expect whales to come this close to active arrays since they would likely hear and see the array prior to this and avoid approaching it at such close range. Furthermore, in many cases, PSOs would detect closely approaching whales and airguns would be shutdown if they enter the exclusion zone. Finally, given that within the near-field and dimensions of the array source levels would be below those in Table 1, we believe exceedance of a particular threshold would only be possible under highly unlikely circumstances (e.g., a whale would need to be in the exact right position, under a particular configuration of airguns, that fire at a particular time). To further evaluate the possibility of such an unlikely circumstance, we calculated the distance to the acoustic thresholds based on a small 90 in^3 array (two 45 in^3 airguns) and a small and large single airgun using source level information provided in Appendix D of BOEM (2014a) (Table 11). If distances to the thresholds for these sources are extremely small or indicate PTS/TTS is not possible, then the conclusion that PTS/TTS is extremely unlikely is further supported.

Based on our above calculations and analysis, we believe that PTS of sperm whales is extremely unlikely to occur, and thus discountable. Moreover, given that the mid frequency cetacean TTS distances for all the arrays are also all within the dimensions of the array and/or the near-field, we also do not anticipate that any individual sperm whales will be exposed to sound fields that would result in TTS, making TTS of sperm whales discountable. However, the estimated distance to PTS for low frequency cetaceans are well beyond the maximum extent of the near-field for all companies except WesternGeco, where the maximum extent of the near-field is approximately equal to the PTS distance. As such, we expect that PTS of low frequency cetaceans is possible for all companies except WesternGeco. In addition, since all the distances to TTS for low frequency cetaceans are all well beyond the maximum extent of the near-field for all companies, we expect that TTS of low frequency cetaceans is possible for all five G&G companies.

Following the above analysis, we discussed our approach and calculations for PTS exposure with the Permits and Conservation Division and NMFS Office of Protected Resources' Acoustic Coordinator. Both parties agreed with our conclusion and the Permits and Conservation Division now do not propose to authorize Level A take of sperm whales in the final IHAs. Our above calculations suggest that PTS of low frequency cetaceans is possible for all companies except WesternGeco. Based on this, public comment, and the estimated amount of Level B exposure for fin whale (see Section *Level B Exposure Estimates* above), the Permits and Conservation Division adjusted their initial Level A exposure analysis for fin whales and now propose to authorize a total of 14 fin whale Level A takes across all five G&G companies (Table 12). This estimate of 14 individual fin whales is based on an assumed exposure of two groups of fin whales to sound levels that would cause PTS for Spectrum, TGS, and CGG, with an assumed group size of two fin whales based on recent AMAPPs data (NMFS 2010a; NMFS 2011a; NMFS 2012a; NMFS 2013a; NMFS 2014; NMFS 2015a; NMFS 2016). For ION, only one group exposure at PTS levels is expected based on the smaller amount of trackline proposed by ION, and for WesternGeco, no PTS exposures are expected given that the distance to the PTS threshold is approximately equal to the maximum extent of the near-field (Table 1). During consultation, we evaluated the Permits and Conservation Division's proposed Level A exposure estimates for fin whales and determined them to reasonably represent the number of individual fin whales expected to be exposed to seismic airgun sounds that would result in PTS, which we consider harm under the ESA.

Table 12. Estimated Level A (Permanent Hearing Threshold Shifts, i.e., harm) exposure of cetaceans to seismic survey sound fields.

Species	ION (July - December)	Spectrum (February - July)	TGS (Year-round)	WesternGeco (Year-round)	CGG (Year-round)	Total
North Atlantic right whale	-	-	-	-	-	-
Sei whale	-	-	-	-	-	-
Fin whale	2	4	4	-	4	14
Blue whale	-	-	-	-	-	-
Sperm whale	-	-	-	-	-	-

In summary, based on the acoustic characteristics of the proposed seismic airgun arrays and what is known about the propagation of sound close to distributed sources such as airgun arrays, we do not expect the proposed seismic surveys to result in PTS (Level A harassment under the MMPA and harm under the ESA) of sperm whales. We recognize that BOEM's PEIS (BOEM 2014a) and the proposed IHAs (82 FR 26244) both proposed Level A take of sperm whales. However, based on our analysis above, which relies on updated acoustic thresholds (NOAA 2018) and the specific acoustic characteristics of the proposed seismic airgun arrays, PTS of sperm whales is not expected to occur. However, we estimate that a total of 14 fin whales may be exposed to sound levels that would result in PTS (Level A harassment under the MMPA and harm under the ESA). These PTS exposures are assumed to be of any age-sex class of fin whales and based on the low number of overall exposures, we do not expect any individual fin whale to be exposed to PTS levels more than once.

9.2.1.2 Sea Turtles

As noted previously, neither action agency nor the five G&G companies estimated exposure of ESA-listed sea turtles to seismic airgun sounds associated with the proposed seismic surveys. As such, we conducted our own exposure analysis. Below we detailed our exposure analysis for sea turtles, which follows a similar approach to that previously described for cetaceans. In this analysis, we rely on acoustic thresholds to determine sound levels at which sea turtles are expected to exhibit a response that may be considered take under the ESA, then utilize these thresholds to calculate ensonified areas, and finally, either multiply these areas by data on sea turtle density, if available, to estimate the number of sea turtles exposed to sound fields generated by airguns, or rely directly on these ensonified areas as a surrogate for sea turtles that would be exposed to sound fields generated by airguns.

Acoustic Thresholds

In order to estimate exposure of ESA-listed sea turtles to sound fields generated by seismic airguns that would be expected to result in a behavioral response that may be considered harassment under the ESA, we relied on the available scientific literature. Currently, the best available data come from studies by O'Hara and Wilcox (1990) and McCauley et al. (2000b), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O'Hara and Wilcox (1990) found that loggerhead turtles exhibited avoidance behavior at estimated sound levels of 175 to 176 dB re: 1 µPa (rms) (or slightly less) in a shallow canal. McCauley et al. (2000b) reported a noticeable increase in swimming behavior for both green and loggerhead turtles at received levels of 166 dB re: 1 µPa (rms). At 175 dB re: 1 µPa (rms), both green and loggerhead turtles displayed increased swimming speed and increasingly erratic behavior (McCauley et al. 2000b). Based on these data, we assume that sea turtles would exhibit a behavioral response in a manner that constitutes harassment under the ESA when exposed to received levels of 175 dB re: 1 µPa (rms) and higher, and so use this threshold to estimate the number of instances of exposure that would result in behavioral harassment.

In order to estimate exposure of ESA-listed sea turtles to sound fields generated by seismic airguns that would be expected to result in sound-induced hearing loss (i.e., TTS or PTS), we relied on acoustic thresholds for PTS and TTS for impulsive sounds developed by the U.S. Navy for Phase III of their programmatic approach to evaluating the environmental effects of their military readiness activities (U.S. Navy 2017a). At the time our exposure analysis was conducted, we considered these to be the best available data since they rely on all available information on sea turtle hearing and employ the same statistical methodology to derive thresholds as in NMFS' recently issued technical guidance for auditory injury of marine mammals (NOAA 2018). Below we briefly detail these thresholds and their derivation. More information can be found in the U.S. Navy's Technical report on the subject (U.S. Navy 2017a).

To estimate received levels from airguns and other impulsive sources expected to produce TTS in sea turtles, the U.S. Navy compiled all sea turtle audiograms available in the literature in an effort to create a composite audiogram for sea turtles as a hearing group. Since these data were insufficient to successfully model a composite audiogram via a fitted curve as was done for marine mammals, median audiogram values were used in forming the hearing group's composite audiogram. Based on this composite audiogram and data on the onset of TTS in fishes, an auditory weighting function was created to estimate the susceptibility of sea turtles to TTS. Data from fishes were used since there are currently no data on TTS for sea turtles and fishes are considered to have hearing more similar to sea turtles than do marine mammals (Popper et al. 2014). Assuming a similar relationship between TTS onset and PTS onset as has been described for humans and the available data on marine mammals, an extrapolation to PTS susceptibility of sea turtles was made based on the methods proposed by (Southall et al. 2007). From on these data and analyses, dual metric thresholds were established similar to those described above for marine mammals: one threshold based on peak sound pressure level (0-pk SPL) that does not incorporate the auditory weighting function nor the duration of exposure, and another based on cumulative sound exposure level (SEL_{cum}) that incorporates both the auditory weighting function and the exposure duration (Table 13).

Table 13. Acoustic thresholds identifying the onset of permanent threshold shift and temporary threshold shift for sea turtles exposed to impulsive sounds (U.S. Navy 2017a)

Hearing Group	Generalized Hearing Range	Permanent Threshold Shift Onset	Temporary Threshold Shift Onset
Sea Turtles	30 Hz to 2 kHz	204 dB re 1 μPa²·s SEL_{cum} 232 dB re: 1 μPa SPL (0-pk)	189 dB re 1 μPa²·s SEL_{cum} 226 dB re: 1 μPa SPL (0-pk)

Exposure Estimates

Using the same approach taken in the *Level A Exposure Estimates* section above for cetaceans, we calculated the distances to each sea turtle threshold, as well as the distances to the near-field at 1 kHz. As with cetaceans, where dual metric thresholds were used (i.e., 0-pk or SEL_{cum} for TTS and PTS), we present the distances to both metrics for comparison, but conservatively rely on the larger distance for determining sea turtle exposure (bold numbers in Table 14).

Table 14. Distance to sea turtle acoustic thresholds. Bolded values indicate which threshold was for exposure estimates since it resulted in the greatest distance. NA indicates not applicable since the source level is not great enough to produce the specified threshold shift.

Company	PTS		TTS		Behavior	Longest Dimension of Array (m)	Maximum Near-field (m)
	Distance (m) to 204 dB re 1 μPa²·s SELcum	Distance (m) to 232 dB re: 1 μPa SPL (0-pk)	Distance (m) to 189 dB re 1 μPa²·s SELcum	Distance (m) to 226 dB re: 1 μPa SPL (0-pk)	Distance (m) to 175 dB re: 1 μPa SPL (rms)		
ION	**22.8**	17.8	**721.4**	35.5	3981.1	37.4	233.1
Spectrum	18.2	**50.1**	**574.4**	100	2511.9	50.0	416.7
TGS	9.1	**14.1**	**287.9**	28.2	1778.3	29.2	142.1
WesternGeco	1.9	**15.8**	**60.7**	31.6	1000.0	21.9[24]	79.9
CGG	**18.2**	11.2	**574.4**	22.4	2511.9	29.1	141.1
BOEM 5300 in^3 Large Array[25]	1.3	**5.6**	**41.4**	11.2	794.3	21.9	79.9
BOEM 90 in^3 Small Array[26]	0.0	NA	0.7	**1.8**	--	--	--
Small airgun[27]	0.0	NA	**0.2**	NA	--	--	--
Large airgun[27]	0.2	**1.4**	**6.6**	2.8	--	--	--

As was the case for the *Level A Exposure Estimates* for sperm whales, all of the estimated distances to PTS for sea turtles were either within the dimensions of the array or the near-field (or both). As such, for the same reasons we do not expect PTS of sperm whales, we do not expect any individual sea turtle to be exposed to sound fields from airguns that would result in PTS. That is, we do not expect sea turtles to come this close to active arrays since they would likely hear and see the array prior to this and avoid it. Furthermore, given that within the near-field and dimensions of the array source levels would be below those in Table 1, we believe exceedance of a particular threshold would only be possible under highly unlikely circumstances. The PTS distances for the small 90 in^3 and small and large airgun indicate that PTS level exposure to individual airguns or a cluster of airguns is not possible unless a sea turtle came within 1.4 m of an active large airgun (Table 14). As such, we believe that PTS of sea turtles is extremely unlikely to occur, and thus discountable. For these same reasons, we believe that TTS of sea turtles resulting from exposure to WesternGeco's array is extremely unlikely to occur and thus discountable given that the largest distances to the TTS threshold for WesternGeco is within the near field. Based on our calculations in Table 14, sea turtles may be exposed to sound levels

[24] WesternGeco did not specify the dimensions of their array but given that they relied on the representative airgun array used in BOEM (2014a) for the acoustic modeling, we relied on the value for *L* specified in BOEM (2014a).
[25] Calculations based on large array source levels from BOEM (2014a) provided for comparison. See Table 1 above for source characteristics.
[26] Calculations based on 90 in^3 array source levels from BOEM (2014a) provided for comparison. See Appendix D, Table D-5 in BOEM (2014a) or source characteristics.
[27]Calculations based on individual airgun source levels from BOEM (2014a). See page Appendix D-12 in BOEM (2014a) or source characteristics

that would be expected to produce TTS (ION, Spectrum, TGS, and CGG) and behavioral responses (all companies) that constitute harassment under the ESA. As such, below we quantify this likely exposure further.

Using the distances from the airgun arrays to the TTS (ION, Spectrum, TGS, and CGG only) and behavioral harassment thresholds (all companies), and each company's tracklines, we estimated the ensonified area that may result from the proposed seismic surveys using a Geographic Information System (GIS, ArcGIS Map 10.4 ESRI, Redlands, California). These ensonified areas were then spatially intersected with sea turtle density data provided by the U.S. Navy (U.S. Navy 2017c), which were extended to cover the entire action area with a nearest neighbor approach (i.e., areas lacking density data assumed the density of the nearest estimate). While we recognize that these sea turtle density data are dated, to our knowledge they represent the best available data within the action area and are being used by the U.S. Navy in consultation with NMFS on Phase III of the U.S. Navy's Atlantic Fleet Training and Testing Area activities [although see Winton et al. (2018) for more recent *relative* loggerhead sea turtle density estimates]. That said, we consider these density estimates to only represent sea turtles greater than 30 cm in size since they are based on aerial surveys, corrected for sighting availability, which can only detect these larger sea turtles (Epperly et al. 1995; NMFS 2011d). In addition, species-specific density estimates are not available for all sea turtles. Specifically, the density data consist of spatial layers that represent Kemp's ridley sea turtles, leatherback sea turtles, loggerhead sea turtles, and hardshell sea turtles that could not be identified to species during the original aerial surveys used to generate the density estimates. Based on recent aerial survey work within the region, the majority of these unidentified hardshell turtles likely represent loggerhead turtles, with the remainder representing green and Kemp's ridley turtles (NMFS 2011d).

Following this spatial intersection, we estimated the total number of sea turtles that would be exposed to sound fields that may cause TTS or behavioral harassment by multiplying the ensonified area covered by the tracklines by the sea turtle density for the time of year that particular area was not closed to seismic surveys due to one of the proposed time-area closures. For example, in areas where seasonal time-area closures are proposed, only sea turtle density data from months when the area is open to surveys were used in calculating the average exposure across months, similar to as was done for cetaceans above. In this process, we also took into account the operating window for the companies that specified it (February through July for Spectrum, July through December for ION) and for the other companies, relied on annual averages of the data. Note that overlapping ensonified areas were treated individually since these areas may be ensonified on different days and thus expose the same sea turtles multiple times or expose additional sea turtles that would not be accounted for if overlapping areas were only considered once. While animals exposed to levels that may result in TTS would also be exposed to levels that may result in behavioral harassment, TTS is considered a more severe response and so the behavioral harassment of animals that may experience TTS is not considered further. The resulting number of sea turtles exposed to levels that may cause TTS and behavioral harassment for each G&G company and in total can be seen in Table 15 below.

Table 15. Estimated exposure of sea turtles (greater than 30 centimeters) to seismic survey sound fields.

Species/ Guild	ION		Spectrum		TGS		WesternGeco		CGG		Total	
	TTS	Behavior	TTS	Behavior	TTS	Behavior	TTS	Behavior	TTS	Behavior	TTS	Behavior
Hardshell	1,717	7,823	1,650	5,657	2,450	12,849	-	2,388	1,265	4,338	6,347	30,537
Kemp's ridley	159	735	217	755	215	1,128	-	473	60	204	527	2,864
Leatherback	1,035	4,712	1,514	5,158	1,678	8,770	-	3,272	2,193	7,529	5,920	27,750
Loggerhead	2,522	11,533	2,135	7,394	3,594	18,901	-	3,980	1,988	6,819	9,271	45,240

As with cetaceans above, it is important to note that the number of exposures presented in Table 15 represent the estimated number of instantaneous moments in which an individual from each species or species group will be exposed to sound fields from seismic surveys at or above the identified thresholds. They do not represent the estimated number of individuals of each species, nor do they provide information on the estimated duration of the exposure. Since the total exposure across all five companies is relatively low compared to the abundance of each sea turtle population that may occur within the action area, we expect that most sea turtles would not be exposed more than once meaning the numbers in Table 15 likely represent individual animals. As for the duration of each instances of exposure estimated in Table 15, we were unable to produce estimates specific to the proposed action due to the temporal and spatial uncertainty of seismic vessels and sea turtles within the action area. However, like with cetaceans, all the exposures presented in Table 15 are expected to be less than a single day in duration due to the movement of seismic vessels and animals, with TTS exposures being shorter in duration that behavioral harassment exposures given the smaller area ensonified to levels expected to result in TTS.

As noted above, the exposure estimates in Table 15 do not include sea turtles less than approximately 30 cm in diameter. These small sea turtles consist of oceanic post-hatchlings and juveniles that typically do not dive very deep and thus, may not frequently enter the area of the loudest sound field produced from a downward pointing airgun array. Although horizontal propagation from airgun arrays is known to occur over many kilometers from the source, sound modeling for airgun arrays are not accurate above and lateral to arrays at distances less than 75-100 m from an array because the sound transmission is much lower and variable in the near field at the surface (Caldwell and Dragoset 2000). Thus, to evaluate the exposure of juvenile sea turtles to sound from downward projecting airgun arrays towed below the water's surface, we examined information on juvenile sea turtle diving behavior.

A study on oceanic post-hatchling and juvenile green, Kemp's ridley, loggerhead, and hawksbill sea turtles found that they may spend the bulk of their time at or within 1 m of the surface (Witherington et al. 2012). Tagged juvenile Kemp's ridley sea turtles spent greater than 93 percent of their time at the surface during the day, and when dives occasionally occurred, depths ranged from 1.7 to 3.7 m. At night, dive depths ranged from 6.3 to 12.8 m. In contrast to this, Freitas et al. (2018) found that juvenile loggerhead sea turtles in the eastern Atlantic spent roughly two-thirds of their time at depths greater than 1 m, with deeper dives occurring during the day. Nonetheless, diving was still relatively shallow with most dives being between 2-6 m, and 95 percent of all dives being less than 50 m (Freitas et al. 2018). Based on the five companies IHA applications, airgun arrays would be towed at depths between 6 to 10 m. Since the tow depths of airgun arrays and dive depths of oceanic juveniles are similar, it is possible that an oceanic juvenile will be located at a depth at which they would be exposed to high source levels from airgun array. However, since juveniles spend much of their time near the surface, in many cases exposure would be less than that predicted by the acoustic modelling, since applying such modelling for near surface waters over estimates sound exposure levels.

The above overview indicates that juvenile sea turtles may be at depths great enough to be considered within the area of downward propagation of an airgun array, but in some cases, they will likely be closer to the surface where sound levels would be lower. In our exposure analysis for juvenile sea turtles, we take a conservative approach and assume that any sea turtle within the footprint of the ensonified area (i.e., within the area ensonified regardless of depth) may be exposed to airguns as if they were within the field of downward propagation. This is the same approach as was taken for larger sea turtles since we did not discount our exposure estimates for the possibility that some larger sea turtles would be near the surface and thus be exposed to lower sound levels than predicted for deeper depths.

To estimate exposure for sea turtles smaller than 30 cm in diameter, ideally we would utilize density estimates on small sea turtles and use a similar analysis as above for larger sea turtles. To our knowledge, there are no small sea turtle density estimates that are appropriate for use across the action area. While Witherington et al. (2012) estimated the density of small green, Kemp’s ridley, and loggerhead sea turtles in two locations in the North Atlantic, these locations are in the southern extent of the action area. Given the expansive geographic region in which the proposed seismic survey would occur, we believe it is inappropriate to simply apply the Witherington et al. (2012) density estimates to the entire action area. This is supported by the fact that the U.S. Navy density estimates for larger sea turtles vary substantially across latitudes within the action area, with density estimates in southern latitudes in some cases being approximately 100 times greater than those in northern latitudes. However, small green, Kemp’s ridley, and loggerhead sea turtles are often associated with *Sargassum* habitats in other locations, and we expect this association to hold true within the action area.

For example, Witherington et al. (2012) found that approximately 89 percent of post-hatchling and juvenile green, Kemp’s ridley, loggerhead, and hawksbill sea turtles were within 1 m of floating *Sargassum* based on surveys in the Gulf of Mexico and off the east coast of Florida, and no differences in this behavior were noted between locations. Moreover, even for those turtles not within 1 m of *Sargassum*, 78 percent of the time the closest object was still *Sargassum* and there was only one observation of a small sea turtle not associated with a floating object (within approximately 100 m). As such, the majority of green, Kemp's ridley, and loggerhead sea turtles less than 30 cm in diameter within the action are expected to be associated with *Sargassum* habitat. The association between small leatherback sea turtles and *Sargassum* habitat is less clear (Salmon et al. 2004; Wyneken and Salmon 1992). Therefore, we do not necessarily expect the majority of small leatherback sea turtles in the action area to be associated with *Sargassum* habitat, and instead assume they would be dispersed throughout the action area.

Gower and King (2011) used satellite imagery to estimate the seasonal extent of *Sargassum* in the North Atlantic and Gulf of Mexico, which provides some insight into where the majority of the small green, Kemp's ridley, and loggerhead sea turtles are likely to be found relative to the proposed seismic surveys. In addition, loggerhead designated critical habitat includes areas expected to be covered by *Sargassum* at some point during the year (see Sections 7.1.5.5 and 7.2.9.5). While this habitat was designated only for loggerheads, it likely contains small sea turtles of all hardshell species regularly found within the action area (green, Kemp's ridley, and loggerhead sea turtles). To estimate the coverage of *Sargassum* habitat in the action area over the course of a year (i.e., covered by *Sargassum* at any point during the year), we georeferenced the extent of *Sargassum* provided in Figure 5 of Gower and King (2011), and calculated the proportion of action area covered by *Sargassum* by combining the monthly estimates of extent of *Sargassum* from Gower and King (2011) with the extent of designated loggerhead *Sargassum* critical habitat. From this, approximately 89 percent of the action area is expected to be covered by *Sargassum* at some point during the course of a year.

While *Sargassum* provides a proxy for the location and extent of small sea turtles, given its expansive coverage of the action area and that not all small sea turtles, especially leatherbacks, are expected to be found within *Sargassum* habitat, we rely on the extent of the ensonified area corresponding to the TTS (ION, Spectrum, TGS, and CGG only) and behavioral harassment (all companies) thresholds as a surrogate to estimate exposure of small sea turtles for all species considered here. Nonetheless, within the ensonified area, we expect that the majority of small green, Kemp's ridley, and loggerhead sea turtles will be found in *Sargassum* habitat. To calculate the total ensonified areas for each company and each acoustic threshold, we calculated the total area of the ensonified tracklines discussed above for the larger sea turtle exposure analysis, with the appropriate trackline segments removed that would not be surveyed due to the proposed closure areas. The resulting ensonified area by company and threshold can be seen in Table 16 below. Any sea turtles less than approximately 30 cm in diameter found within these ensonified areas would be exposed to sound fields that may cause TTS or result in behavioral harassment.

Table 16. Estimated exposure of small sea turtles (less than 30 centimeters) based on the ensonified area that may result in temporary threshold shifts or behavioral harassment.

Company	TTS Ensonified Area (km²)	Behavioral Harassment Ensonified Area (km²)
ION	18,508	84,485
Spectrum	23,916	81,664
TGS	32,035	167,912
WesternGeco	-	52,758
CGG	32,243	110,609
Total	**106,702**	**497,428**

9.2.2 Response Analysis

Given the above estimated exposure of ESA-listed cetaceans and sea turtles to seismic airgun sound fields associated with the proposed action, in this section we describe the range of responses these species may exhibit to this exposure. This includes behavioral responses and sound-induced hearing loss (i.e., TTS and PTS), which were used to establish thresholds for our exposure analysis, as well as other possible responses that cetaceans and sea turtles may exhibit to exposure to seismic airgun sound fields. We organize these responses first by species group, and then by the nature of the response. In addition, we review the possible response of cetacean and sea turtle prey, as responses by prey may indirectly affect ESA-listed cetaceans and sea turtles.

Our aim with this response analysis is to assess the potential responses that might reduce the fitness of individual ESA-listed cetaceans and sea turtles. In doing so, we consider and weigh evidence of adverse consequences, as well as evidence suggesting the absence of such consequences. In cases where data on the responses of the ESA-listed species considered in this opinion to seismic airgun sound fields are not available, we rely on data from other closely related species. In addition, we rely on information on the responses of ESA-listed species, as well as other related species, to anthropogenic sound sources other than seismic airguns. We recognize that there can be species and sound specific responses, and even within species, not all individual animals are likely to respond to all sounds in the same way. Nonetheless, by examining the range of responses that ESA-listed and other related species exhibit to anthropogenic sounds, we incorporate uncertainty in our analysis that stems from intra- and inter-species response heterogeneity and make use of the best available science.

9.2.2.1 Cetaceans

A pulse of sound from an airgun displaces water around the airgun and creates a wave of pressure, resulting in physical effects on the marine environment that can then affect marine organisms, such as the ESA-listed cetaceans considered in this opinion. In this section, we review what is known about the following possible responses that ESA-listed cetaceans may exhibit in response to exposure to seismic airgun sound fields (Aguilar de Soto et al. 2016; Gordon et al. 2003; Götz et al. 2009; Nowacek et al. 2007; Southall et al. 2007):

- Hearing threshold shifts
- Masking (auditory interference)
- Behavioral responses
- Non-auditory physical or physiological responses
- Stranding

Hearing Threshold Shifts

Exposure of cetaceans to very strong impulsive sound sources from airgun arrays can result in auditory damage, such as changes to sensory hairs in the inner ear, which may temporarily or permanently impair hearing by decreasing the range of sound an animal can detect within its normal hearing ranges (reviewed in Finneran 2015). Hearing threshold shifts depend upon the duration, frequency, sound pressure, and rise time of the sound. A TTS results in a temporary change to hearing sensitivity, and the impairment can last minutes to days, but full recovery of hearing sensitivity is expected. Some investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (Ward 1997). However, a study looking at the effects of sound on mice hearing, has shown that although full hearing can be regained from TTS (i.e., the sensory cells actually receiving sound are normal), damage can still occur to nerves of the cochlear nerve leading to delayed but permanent hearing damage (Kujawa and Liberman 2009). At higher received levels, particularly in frequency ranges where animals are more sensitive, PTS can occur, meaning lost auditory sensitivity is unrecoverable. Either of these conditions can result from exposure to a single pulse or from the accumulation of multiple pulses, in which case each pulse need not be as loud as a single pulse to have the same accumulated effect. TTS and PTS are generally specific to the frequencies over which exposure occurs but can extend to a half-octave above or below the center frequency of the source in tonal exposures, which is less evident in broadband sounds such as the sound sources associated with the proposed action (Kastak et al. 2005; Ketten 2012; Schlundt et al. 2000).

Based on our exposure analysis, only fin whales are expected to be experience to sound fields that would cause PTS (for ION, Spectrum, TGS, and CGG only). The available data suggest that such PTS would primarily occur at frequencies where the majority of the energy from seismic airgun sounds occurs (below 200 Hz). This overlaps with the frequencies of fin whale calls (10 to 200 Hz) and the general hearing range of fin whales (7 Hz to 35 kHz), so PTS of fin whales may interfere with their ability to communicate, although the PTS would be at frequencies below their estimated range of maximum sensitivity (1 to 2 kHz, see Section 7.2.2.3).

While PTS of fin whales would result in permanent hearing loss, the effects of such hearing loss are expected to be minor for several reasons. First, the acoustic PTS thresholds used in our exposure analysis represent thresholds for the onset of PTS (i.e., the minimum sound levels at which minor PTS could occur; Finneran 2015; NOAA 2018; Southall et al. 2007), not thresholds for moderate or severe PTS. In order to determine the likelihood of moderate or severe PTS, one needs to consider the duration of fin whale exposure at the PTS onset threshold distances from the airgun arrays or closer since PTS of fin whales is expected based on cumulative sound exposure level rather than instantaneous exposure to peak sound pressure levels (Table 11). Based on the acoustic characteristics of the proposed airgun arrays and assuming the safe distance methodology proposed by Sivle et al. (2014), distances to the thresholds for the onset of PTS range from approximately 380 to 960 m. These distances, combined with studies that suggest that most baleen whales, including fin whales, avoid closely approaching active airguns arrays (Barkaszi et al. 2012; Castellote et al. 2012; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007; Stone et al. 2017a; Stone and Tasker 2006), indicate that while fin whales would experience PTS, such PTS exposure would be brief and at or near PTS onset levels and not much higher. For example, a recent study analyzing 16 years of PSO data consisting of marine mammal observations during seismic surveys in waters off the United Kingdom found that the median closest approach by fin whales during active airgun use was 1,225 m (Stone et al. 2017a), a distance well beyond the PTS onset threshold distances estimated for the proposed seismic airgun arrays. Second, the proposed conservation measures are expected to minimize PTS of fin whales. The use of a ramp-up procedure should alert fin whales to the nearby acoustic source before the airgun array is at full power, giving them an opportunity to leave the area prior to receiving sound levels that would cause PTS (Stone et al. 2017a, although see Dunlop et al. 2016). In addition, while the use of PSOs and the requirement for shutdowns would not necessarily prevent exposure to sound levels that would cause PTS, they would reduce the duration of exposure. Thus, based on the estimated amount of PTS exposure (sound level and duration) and the proposed conservation measures, fin whales are expected to experience only minor PTS, which may have minor effects on their ability to hear conspecific calls and/or other environmental cues.

TTS is not expected for sperm whales, but some of the Level B exposures of ESA-listed baleen whales (blue, fin, North Atlantic right, and sei whales, see Table 10) are expected to involve TTS. However, these exposures are expected to be minor for several reasons. First, as noted above, the available evidence suggests that baleen whales tend to avoid closely approaching active seismic sources (Barkaszi et al. 2012; Castellote et al. 2012; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007; Stone et al. 2017a; Stone and Tasker 2006). While avoidance of airgun arrays at close distances would not prevent TTS (Gedamke et al. 2011), depending on the circumstances, it may decrease the duration that animals receive levels that would cause TTS, and thus the severity of the TTS. Furthermore, some species, such as bowhead whales which are closely related to North Atlantic right whales, exhibit avoidance at low received levels and at far distances [120 to 130 dB re: 1 µPa (rms) at distances of 20 to 30 km], which may prevent TTS entirely (Richardson et al. 1999). Second, as discussed for PTS of fin whales above, we expect the proposed conservation measures requiring ramp-up and shutdowns would reduce instances of TTS and the severity of TTS respectively. Despite these factors that minimize the potential and severity of TTS, we assume that some blue, fin, North Atlantic right, and sei whales will experience TTS as the result of being exposed to active seismic sources. As is the nature of TTS, such effects would be temporary and exposed individuals' hearing would return to normal within minutes to days.

Masking

Interference, or masking, occurs when a sound is a similar frequency and similar to or louder than the sound an animal is trying to hear (Clark et al. 2009; Erbe et al. 2016). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Richardson 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options.

There is frequency overlap between airgun array sounds and vocalizations of ESA-listed cetaceans, particularly baleen whales and to some extent sperm whales. As such, the proposed seismic surveys could mask these calls at some of the lower frequencies for these species. Any masking that might result from seismic airguns would be temporary because these acoustic sources are not continuous and the vessels would continue to transit through the area. However, despite the fact that sound pulses from airguns are short, discrete sounds, they interact with the marine environment and lengthen through processes such as reverberation. This means that in some cases, such as in shallow water environments, airgun sound can become part of the acoustic background. Few studies of how impulsive sound in the marine environment deforms from short bursts to lengthened waveforms exist, but they can add significantly to the acoustic background (Guerra et al. 2011), potentially interfering with the ability of animals to hear otherwise detectible sounds in their environment. Such masking could affect communication between individuals, affect their ability to receive information from their environment, or affect their foraging (Evans 1998; NMFS 2006c).

Sperm whales use echolocation to locate their prey and communicate using short repeated clicks known as codas. Most of the energy of the sperm whale clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz (Goold and Jones 1995; Weilgart and Whitehead 1993). While Madsen et al. (2006) suggest that the frequencies of airgun pulses can overlap this range, the predominant frequencies of airguns are below 200 Hz. Given this disparity between sperm whale echolocation and communication-related sounds with the dominant frequencies for seismic surveys, the proposed seismic surveys are not likely to significantly interfere with or mask sperm whale acoustic cues.

The baleen whales considered in this opinion (blue, fin, North Atlantic right, and sei whales) hear best and produce calls at low frequencies. As such, the overlap between their calls and the dominant low frequencies of airgun pulses is expected to pose a greater risk of masking than there is for sperm whales. In fact, some low frequency sounds, such as those produced by large commercial vessels, are estimated to have reduced the communication space for North Atlantic right whales in the Northeastern United States by up to 67 percent compared to historically lower sound conditions (Hatch et al. 2012). While masking due to vessel sound may be more severe for some North Atlantic right whale sounds (e.g., upcalls) compared to those produced by fin whales (Clark et al. 2009), some masking of fin whale sounds, as well as those produced by blue and sei whales, likely occurs. In fact, masking is likely heavily dependent on the call type. For example, North Atlantic right whale gunshot calls appear to be much less susceptible to masking compared to fin whale songs (Cholewiak et al. 2018). Importantly, ambient sound levels in the action area are much lower than in the Northeastern United States where these studies on masking have been performed (Parks et al. 2009). As such, the addition of sound from the proposed seismic airguns surveys may have a greater overall masking affect within the action area, as compared to in the Northeastern United States where ambient sound levels are already high.

The sound localization abilities of marine mammals suggest that, if a signal (i.e., the sound of interest) and the background sound (i.e., that which may cause masking) come from different directions, masking will not be as severe as the usual types of masking studies might suggest (Richardson 1995). The dominant background sound may be highly directional if it comes from a particular anthropogenic source such as a vessel or industrial site. Directional hearing may significantly reduce the masking effects of these sounds by improving the effective signal-to-sound ratio. In the cases of higher frequency hearing by the bottlenose dolphin (*Tursiops truncatus*), beluga whale (*Delphinapterus leucas*), and killer whale (*Orcinus orca*), empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking sound (Au et al. 1985; Bain and Dahlheim 1994; Bain et al. 1993; Dubrovskiy and Giro 2004). Toothed whales such as sperm whales, and probably other marine mammals, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background sound. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient sound toward frequencies with less sound (Au 1975; Au et al. 1985; Au et al. 1974; Lesage et al. 1999; Moore and Pawloski 1990; Romanenko and Kitain 1992; Thomas et al. 1990). A few marine mammal species increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Au 1993; Dahlheim 1987; Foote et al. 2004; Holt et al. 2009; Lesage et al. 1993; Lesage et al. 1999; Parks 2009; Parks et al. 2007a; Terhune 1999).

These data suggest that some marine mammals may have adaptations to reduce masking, particularly that of high frequency echolocation signals produced by toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva et al. (1980) found that, for bottlenose dolphins, the angular separation between a sound source and a masking sound source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Studies have noted directional hearing at frequencies as low as 0.5 to 2 kHz in several marine mammals, including killer whales (Richardson et al. 1995). This ability may be useful in reducing masking at these frequencies.

In summary, the high levels of sound generated by the proposed seismic airgun surveys may act to mask the detection of weaker biologically important sounds by some of the cetaceans considered in this opinion. This masking is expected to be more prominent for baleen whales given the frequencies at which they hear best and produce calls. Sperm whales, hear best at frequencies above the predominant ones produced by seismic airguns and like other toothed whales mentioned above (e.g., belugas, Au et al. 1985), may have adaptations to allow them to reduce the effects of masking on higher frequency sounds such as echolocation clicks. As such, sperm whales are not expected to experience significant masking.

Behavioral Responses

We expect the greatest response of marine mammals to airgun sounds in terms of number of responses and overall impact to be in the form of changes in behavior. Individual ESA-listed cetaceans may briefly respond to underwater sound by slightly changing their behavior or relocating a short distance, in which case the effects can equate to take but are unlikely to be significant at the population level. Displacement from important feeding or breeding areas over a prolonged period would likely be more significant. This has been suggested for humpback whales along the Brazilian coast as a result of increased seismic survey activity (Parente et al. 2007). Marine mammal responses to anthropogenic sound vary by species, state of maturity, prior exposure, current activity, reproductive state, time of day, and other factors (Ellison et al. 2012; Ellison et al. 2018; Harris et al. 2018); this is reflected in a variety of aquatic, aerial, and terrestrial animal responses to anthropogenic sound that may ultimately have fitness consequences (Costa et al. 2016b; Fleishman et al. 2016; Francis and Barber 2013; New et al. 2014; NRC 2005). Although some studies are available which address responses of ESA-listed cetaceans considered in this opinion directly, additional studies on other related whales (such as bowhead and gray whales) are relevant in determining the responses expected by species under consideration. This is particularly true for North Atlantic right whales, for which data on their responses to seismic airguns are unavailable. Therefore, studies from non-ESA-listed or species outside the action area are also considered here, especially for bowhead whales, since they are closely related to North Atlantic right whales. Animals generally respond to anthropogenic perturbations as they will predators, increasing vigilance, and altering habitat selection (Reep et al. 2011). There is increasing support that this predator like response is true for animals' response to anthropogenic sound (Harris et al. 2018). Habitat abandonment due to anthropogenic sound exposure has been found in terrestrial species (reviewed in Francis and Barber 2013). Because of the similarities in hearing anatomy of terrestrial and marine mammals, we expect it possible for ESA-listed cetaceans to behave in a similar manner as terrestrial mammals when they detect a sound stimulus. For additional information on the behavioral responses marine mammals exhibit in response to anthropogenic noise, including non-ESA-listed species, see the Federal Register Notice associated with the draft IHAs (82 FR 26244) as well as one of several reviews (e.g., Gomez et al. 2016; Southall et al. 2007).

Several studies have aided in assessing the various levels at which whales may modify or stop their calls in response to sounds for airguns. Many whales continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006; Madsen et al. 2002; McDonald et al. 1993; McDonald et al. 1995; Nieukirk et al. 2004; Richardson et al. 1986; Smultea et al. 2004; Tyack et al. 2003). However, male humpback whales increasingly stopped vocal displays on Angolan breeding grounds as received seismic airgun levels increased (Cerchio et al. 2014). Some blue, fin, and sperm whales stopped calling for short and long periods apparently in response to airguns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while airguns were operational as well as for at least a week thereafter (Castellote et al. 2012). Dunn and Hernandez (2009) tracked blue whales during a seismic survey and did not observe changes in call rates and found no evidence of anomalous behavior that they could directly ascribe to the use of airguns at sound levels of approximately less than 145 dB re: 1 μPa (rms). Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Di Iorio and Clark 2009). Bowhead whale calling rates were found to decrease during migration in the Beaufort Sea when seismic surveys were being conducted (Nations et al. 2009). Calling rates decreased when exposed to seismic airguns at estimated received levels of 116 to 129 dB re: 1 μPa (rms), but did not change at received levels of 99 to 108 dB re: 1 μPa (rms) (Blackwell et al. 2013). A more recent study examining cumulative sound exposure found that bowhead whales began to increase call rates as soon as airgun sounds were detectable, but this increase leveled off at approximate 94 dB re: 1 μPa^2-s over the course of 10 minutes (Blackwell et al. 2015). Once sound levels exceeded approximately 127 dB re: 1 μPa^2-s over 10 minutes, call rates began to decline and at approximately 160 dB re: 1 μPa^2-s over 10 minutes, bowhead whales appeared ceased calling all together (Blackwell et al. 2015). While we are aware of no data documenting changes in North Atlantic right whale vocalization in association with seismic surveys, as mentioned previously they do shift calling frequencies and increase call amplitude over both long and short term periods due to chronic exposure to vessel sound (Parks and Clark 2007; Parks et al. 2007a; Parks et al. 2011a; Parks et al. 2012b; Parks et al. 2009; Tennessen and Parks 2016). Sperm whales, at least under some conditions, may be particularly sensitive to airgun sounds, as they have been documented to cease calling in association with airguns being fired hundreds of kilometers away (Bowles et al. 1994). Other studies have found no response by sperm whales to received airgun sound levels up to 146 dB re: 1 μPa (peak-to-peak) (Madsen et al. 2002; McCall Howard 1999). Given the available data, we assume that some individual ESA-listed cetaceans exposed to seismic airgun sounds may cease calling or otherwise alter their vocal behavior. However, we expect that such responses would be temporary and animals would resume or modify calling at a later time or location away from the seismic source.

There are numerous studies on other behavioral responses baleen whales exhibit to airguns. Although responses to lower-amplitude sounds are known, most studies seem to support a threshold of approximately 160 dB re: 1 µPa (rms) as the received sound level to cause behavioral responses other than vocalization changes (Richardson et al. 1995). Activity of individuals seems to influence response (Robertson et al. 2013), as feeding individuals respond less than mother and calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995; Richardson et al. 1999). In bowhead whales, surface duration decreased markedly during exposure to airgun sounds, especially while individuals were engaged in traveling or non-calf social interactions (Robertson et al. 2013). In addition, migrating bowhead whales show strong avoidance reactions to received 120 to 130 dB re: 1 µPa (rms) exposures at distances of 20 to 30 km, but only changed dive and respiratory patterns while feeding and showed avoidance at higher received sound levels (152 to 178 dB re: 1 µPa [rms]) (Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995; Richardson et al. 1999; Richardson et al. 1986). Nations et al. (2009) also found that bowhead whales were displaced during migration in the Beaufort Sea during active seismic surveys. In fact, as mentioned previously, the available data indicate that most, if not all, baleen whale species exhibit avoidance of active seismic airguns (Barkaszi et al. 2012; Castellote et al. 2012; Gordon et al. 2003; NAS 2017; Potter et al. 2007; Southall et al. 2007; Stone et al. 2017a; Stone and Tasker 2006). Despite the above observations and exposure to repeated seismic surveys, bowhead whales continue to return to summer feeding areas and when displaced, appear to re-occupy within a day (Richardson et al. 1986). We do not know whether the individuals exposed in these ensonified areas are the same returning or whether though they tolerate repeat exposures, they may still experience a stress response.

Gray whales respond similarly to seismic surveys as described for bowhead whales. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re: 1 µPa (rms) (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986; Malme et al. 1988; Meier et al. 2007; Würsig et al. 1999; Yazvenko et al. 2007). Migrating gray whales began to show changes in swimming patterns at approximately 160 dB re: 1 µPa (rms) and slight behavioral changes at 140 to 160 re: 1 µPa (rms) (Malme and Miles 1985; Malme et al. 1984). As with bowhead whales, habitat continues to be used despite frequent seismic survey activity, and long-term effects have not been identified (Malme et al. 1984). Furthermore, when strict mitigation measures are taken to avoid conducting surveys during certain times of the year when most gray whales are expected to be present and to closely monitor operations, gray whales may not exhibit any noticeable behavioral responses to seismic activity (Gailey et al. 2016; Racca et al. 2016).

Humpback whales exhibit a pattern of lower threshold responses when not occupied with feeding. Migrating humpbacks altered their travel path (at least locally) along Western Australia at received levels as low as 140 dB re: 1 µPa (rms) when females with calves were present (McCauley et al. 2000b; McCauley et al. 1998). A startle response occurred as low as 112 dB re: 1 µPa (rms). Closest approaches were generally limited to 3 to 4 km, although some individuals (mainly males) approached to within 100 m on occasion where sound levels were 179 dB re: 1 μPa (rms). Changes in course and speed generally occurred at estimated received levels of 157 to 164 dB re: 1 μPa (rms). Similarly, off the east coast of Australia, migrating humpback whales are more likely to avoid seismic airguns (single airgun, small cluster array, and full-scale commercial array) at distances of 4 km at levels of 140 dB re: 1 μPa^2-s (Dunlop et al. 2018). However, whales exhibited no abnormal behaviors to the active seismic array, and while there were detectible changes in respiration and diving, these were relatively small in magnitude and similar to those observed when baseline groups (i.e., not exposed to active seismic sources) were joined by another whale (Dunlop et al. 2017; Dunlop et al. 2018). While some whales were also found to reduce their speed and change course along their migratory route, overall these results suggest that the behavioral responses exhibited by humpback whales are unlikely to have significant biological consequences for fitness (Dunlop et al. 2017; Dunlop et al. 2018). Feeding humpback whales appear to be somewhat more tolerant. Humpback whales off the coast of Alaska startled at 150 to 169 dB re: 1 μPa (rms) and no clear evidence of avoidance was apparent at received levels up to 172 dB re: 1 μPa (rms) (Malme et al. 1984; Malme et al. 1985). Potter et al. (2007) found that humpback whales on feeding grounds in the Atlantic Ocean did exhibit localized avoidance to airguns. Among humpback whales on Angolan breeding grounds, no clear difference was observed in encounter rate or point of closest approach during seismic versus non-seismic periods (Weir 2008).

Observational data are sparse for specific baleen whale life histories (breeding and feeding grounds) in response to airguns. As noted above, the available data support a general avoidance response. Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone et al. 2017a; Stone and Tasker 2006). Other studies have found at least small differences in sighting rates (lower during seismic activities) as well as whales being more distant during seismic operations (Moulton and Miller 2005). When spotted at the average sighting distance, individuals will have likely been exposed to approximately 169 dB re: 1 μPa (rms) (Moulton and Miller 2005). While we are aware of no data on North Atlantic right whale responses to seismic activity, they have been observed to strongly respond to sound designed to alert whales to vessel presence by rapidly surfacing, though they did not appear to exhibit an overt behavioral response to vessel sounds themselves (Nowacek et al. 2004).

Sperm whale response to airguns has thus far included mild behavioral disturbance (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found sperm whales in the Atlantic Ocean to show little or no response (Davis et al. 2000; Madsen et al. 2006; Miller et al. 2009; Moulton and Miller 2005; Stone 2003; Stone et al. 2017a; Stone and Tasker 2006; Weir 2008). Detailed study of sperm whales in the Gulf of Mexico suggests some alteration in foraging from less than 130 to 162 dB re: 1 μPa peak-to-peak, although other behavioral reactions were not noted by several authors (Gordon et al. 2006; Gordon et al. 2003; Jochens et al. 2006; Madsen et al. 2006; Winsor and Mate 2006). This has been contradicted by other studies, which found avoidance reactions by sperm whales in the Gulf of Mexico in response to seismic ensonification (Jochens and Biggs 2003; Jochens and Biggs 2004; Mate et al. 1994). Johnson and Miller (2002) noted possible avoidance at received sound levels of 137 dB re: 1 µPa. Other anthropogenic sounds, such as pingers and sonars, disrupt sperm whale behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). Miller et al. (2009) found sperm whales to be generally unresponsive to airgun exposure in the Gulf of Mexico, although foraging behavior may have been affected based on changes in echolocation rate and slight changes in dive behavior. Displacement from the area was not observed. Winsor and Mate (2013) did not find a non-random distribution of satellite-tagged sperm whales at and beyond 5 km from airgun arrays, suggesting individuals were not displaced or move away from the airgun array at and beyond these distances in the Gulf of Mexico (Winsor and Mate 2013). However, no tagged whales within 5 km were available to assess potential displacement within 5 km (Winsor and Mate 2013). In a follow up study using additional data, Winsor et al. (2017) found no evidence to suggest sperm whales avoid active seismic airguns within distances of 50 km. The lack of response by this species may in part be due to its higher range of hearing sensitivity and the low-frequency (generally less than 200 Hz) pulses produced by seismic airguns (Richardson et al. 1995). However, sperm whales are exposed to considerable energy above 500 Hz during the course of seismic surveys (Goold and Fish 1998), so even though this species generally hears best at higher frequencies, this does not mean that it cannot hear airgun sounds. Breitzke et al. (2008) found that source levels were approximately 30 dB re: 1 µPa lower at 1 kHz and 60 dB re: 1 µPa lower at 80 kHz compared to dominant frequencies during a seismic source calibration. Reactions of sperm whales to impulse sound likely vary depending on the activity at time of exposure. For example, in the presence of abundant food or during breeding encounters, toothed whales sometimes are extremely tolerant of sound pulses (NMFS 2010b).

In summary, ESA-listed cetaceans are expected to exhibit a wide range of behavioral responses when exposed to seismic airgun sound fields. Baleen whales are expected to mostly exhibit avoidance behavior, and may also alter their vocalizations. Sperm whales are expected to exhibit less overt behavioral changes, but may alter foraging behavior, including echolocation vocalizations. These responses are expected to be temporary with behavior returning to a baseline state shortly after the seismic source becomes inactive or leaves the area.

Non-auditory Physical and Physiological Responses

Individual whales exposed to sound fields generated by seismic airguns could exhibit responses not readily observable, such as stress (Romano et al. 2002), that may have adverse effects. Other possible responses to impulsive sound sources like seismic airguns include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox et al. 2006; Southall et al. 2007; Tal et al. 2015; Zimmer and Tyack 2007), but similar to stress, these effects are not readily observable. Importantly, these more severe physical and physiological responses have been associated with explosives and/or mid-frequency tactical sonar, not seismic airguns.

We do not expect ESA-listed cetaceans to experience any of these more severe physical and physiological responses as a result of the proposed seismic surveys.

Stress is an adaptive response and does not normally place an animal at risk. Distress involves a stress response resulting in a negative biological consequence to the individual. The vertebrate stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch and Hayward 2009; Gregory and Schmid 2001; Gulland et al. 1999; St. Aubin and Geraci 1988; St. Aubin et al. 1996; Thomson and Geraci 1986). These hormones subsequently can cause short-term weight loss, the liberation of glucose into the blood stream, impairment of the immune and nervous systems, elevated heart rate, body temperature, blood pressure, and alertness, and other responses (Busch and Hayward 2009; Cattet et al. 2003; Costantini et al. 2011; Dickens et al. 2010; Dierauf and Gulland 2001; Elftman et al. 2007; Fonfara et al. 2007; Kaufman and Kaufman 1994; Mancia et al. 2008; Noda et al. 2007; Thomson and Geraci 1986). In some species, stress can also increase an individual’s susceptibility to gastrointestinal parasitism (Greer et al. 2005). In highly stressful circumstances, or in species prone to strong “fight-or-flight” responses, more extreme consequences can result, including muscle damage and death (Cowan and Curry 1998; Cowan and Curry 2002; Cowan and Curry 2008; Herraez et al. 2007). The most widely-recognized indicator of vertebrate stress, cortisol, normally takes hours to days to return to baseline levels following a significantly stressful event, but other hormones of the hypothalamic-pituitary-adrenal axis may persist for weeks (Dierauf and Gulland 2001). Stress levels can vary by age, sex, season, and health status (Gardiner and Hall 1997; Hunt et al. 2006; Keay et al. 2006; Romero et al. 2008; St. Aubin et al. 1996). For example, stress is lower in immature North Atlantic right whales than adults, and mammals with poor diets or undergoing dietary change tend to have higher fecal cortisol levels (Hunt et al. 2006; Keay et al. 2006).

Loud sounds generally increase stress indicators in mammals (Kight and Swaddle 2011). Romano et al. (2004) found that beluga whales and bottlenose dolphins exposed to a seismic watergun (up to 228 dB re: 1 μPa m peak-to-peak and single pure tones up to 201 dB re: 1 μPa) had increases in stress chemicals, including catecholamines, which could affect an individual’s ability to fight off disease. During the time following September 11, 2001, shipping traffic and associated ocean sound decreased along the northeastern United States. This decrease in ocean sound was associated with a significant decline in fecal stress hormones in North Atlantic right whales, providing evidence that chronic exposure to increased sound levels, although not acutely injurious, can produce stress (Rolland et al. 2012). These levels returned to baseline after 24 hours of traffic resuming.

Since whales use hearing for communication and as a primary way to gather information about the environment, we assume that limiting these abilities, as is the case when masking occurs, will be stressful. We also assume that any individuals exposed to levels sufficient to trigger onset of

PTS or TTS would also experience physiological stress response (NMFS 2006b; NRC 2003). Finally, we assume that some individuals exposed at levels below those required to induce a TTS, but above the Level B 160 dB re: 1 μPa (rms) threshold, will experience a stress response, which may also be associated with an overt behavioral response. However, since in all cases exposure to sounds from seismic airguns are expected to be temporary, we expect any such stress responses to be short-term. Given the available data, animals would be expected to return to a baseline state (e.g., baseline cortisol level) within hours to days, with the duration of the stress response depending on the severity of the exposure (i.e., we expect a TTS exposure would result in a longer duration before returning to a baseline state as compared to exposure to levels below the TTS threshold).

Data specific to cetaceans are not readily available to access other non-auditory physical and physiological responses to sound. However, based on studies of other vertebrates, exposure to loud sound may also adversely affect reproductive and metabolic physiology (reviewed in Kight and Swaddle 2011). Premature birth and indicators of developmental instability (possibly due to disruptions in calcium regulation) have been found in embryonic and neonatal rats exposed to loud sound. Fish eggs and embryos exposed to sound levels only 15 dB greater than background showed increased mortality and surviving fry had slower growth rates, although the opposite trends have also been found in sea bream. Studies of rats have shown that their small intestine leaks additional cellular fluid during loud sound exposure, potentially exposing individuals to a higher risk of infection (reflected by increases in regional immune response in experimental animals). In addition, exposure to 12 hours of loud sound may alter cardiac tissue in rats. In a variety of response categories, including behavioral and physiological responses, female animals appear to be more sensitive or respond more strongly than males. It is noteworthy that although various exposures to loud sound appear to have adverse results, exposure to music largely appears to result in beneficial effects in diverse taxa. Clearly, the impacts of even loud sound are complex and not universally negative (Kight and Swaddle 2011). Given the available data, and the short duration of exposure to sounds generated by seismic airguns, we do not anticipate any effects to reproductive and metabolic physiology of ESA-listed cetaceans.

Stranding

There is some concern regarding the coincidence of marine mammal strandings and proximal seismic survey, though no conclusive evidence exists to causally link stranding events to seismic surveys. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (IAGC 2004; IWC 2007a). In September 2002, two Cuvier's beaked whales (*Ziphius cavirostris*) stranded in the Gulf of California, Mexico. The R/V *Maurice Ewing* had been operating a 20-airgun array (8,490 in^3) 22 km offshore the general area at the time that stranding occurred. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence, as the individuals who happened upon the stranding were ill equipped to perform an adequate necropsy (Taylor et al. 2004). Furthermore, the small numbers of animals involved and the lack of knowledge regarding the spatial and temporal correlation between the beaked whales and the sound source underlies the uncertainty regarding the linkage between sound sources from seismic surveys and beaked whale strandings (Cox et al. 2006). Numerous studies suggest that the physiology, behavior, habitat relationships, age, or condition of cetaceans may cause them to strand or might pre-dispose them to strand when exposed to another phenomenon. These suggestions are consistent with the conclusions of numerous other studies that have demonstrated that combinations of dissimilar stressors commonly combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other does not produce the same result (Creel 2005; Fair and Becker 2000; Moberg 2000; Romano et al. 2004; Sih et al. 2004). At present, the factors of airguns from seismic surveys that may contribute to marine mammal strandings are unknown and we have no evidence to lead us to believe that aspects of the airgun array proposed for use will cause marine mammal strandings. We do not expect ESA-listed cetaceans to strand as a result of the proposed seismic surveys.

9.2.2.2 Sea Turtles

As with cetaceans, ESA-listed sea turtles may exhibit a variety of different responses to sound fields associated with seismic airguns. Below we review what is known about the following responses that ESA-listed sea turtles may exhibit (reviewed in Nelms et al. 2016):

- Hearing threshold shifts
- Behavioral responses
- Non-auditory physical or physiological responses

To our knowledge, strandings of sea turtles in association with anthropogenic sound has not been documented, and so no such stranding response is expected. In addition, masking is not expected to affect sea turtles since they are not known to rely heavily on acoustics for life functions (Nelms et al. 2016; Popper et al. 2014).

Hearing Threshold Shifts
Like marine mammals, if exposed to loud sounds sea turtles may experience TTS and/or PTS. Although all sea turtle species studied exhibit the ability to detect low frequency sound, the potential effects of exposure to loud sounds on sea turtle biology remain largely unknown (Nelms et al. 2016; Samuel et al. 2005). The only study which addressed sea turtle TTS was conducted by Moein et al. (1994), in which a loggerhead turtle experienced TTS upon multiple airgun exposures in a shallow water enclosure, but recovered full hearing sensitivity within one day.

As with marine mammals, we assume that sea turtles will not move towards a sound source that causes them stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sound sources (McCauley et al. 2000a; McCauley et al. 2000b; Moein et al. 1994), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid airguns and are likely exposed to higher levels of pulses from seismic airgun arrays

(Smultea and Holst 2003). However, even if sea turtles are in close proximity, based on our exposure analysis we would only expect TTS to occur, no PTS, and in most cases, we expect sea turtles will move away from sounds produced by the airgun array. For those individuals that would experience TTS, the available data suggest hearing would return to normal within days of the exposure (Moein et al. 1994).

Behavioral Responses

As with ESA-listed marine mammals, it is likely that sea turtles will exhibit behavioral responses. Behavioral responses to human activity have been investigated for several species of sea turtles: green and loggerhead (McCauley et al. 2000b; O'Hara and Wilcox 1990); and leatherback, loggerhead, olive ridley, and 160 unidentified turtles (hard-shell species) (Weir 2007). The work by O’Hara and Wilcox (1990) and McCauley et al. (2000b) on loggerhead turtles were previously discussed in Section 9.2.1.2. These studies formed the basis of our 175 dB re: 1 µPa (rms) threshold for determining when sea turtle would be harassed due to sound exposure since at and above this level, loggerheads were observed to exhibit avoidance behavior, increased swimming speed, and erratic behavior. Loggerhead turtles have also been observed to move towards the surface upon airgun exposure (Lenhardt 1994; Lenhardt et al. 1983). In contrast, loggerhead turtles resting at the ocean surface were observed to startle and dive as an active seismic source approached them, with the responses decreasing with increasing distance (Deruiter and Larbi Doukara 2012). However, some of these animals may have reacted to the ship’s presence rather than the seismic source specifically (Deruiter and Larbi Doukara 2012). Monitoring reports from seismic surveys show that some sea turtles move away from approaching airgun arrays, although sea turtles may approach active airgun arrays within 10 m with minor behavioral responses (Holst et al. 2006; Holst and Smultea 2008; Holst et al. 2005b; NMFS 2006a; NMFS 2006c; Smultea et al. 2005).

Observational evidence suggests that sea turtles are not as sensitive to sound as are marine mammals and behavioral changes are only expected when sound levels rise above received sound levels of 175 dB re: 1 µPa (rms). If exposed at such levels, based on the available data we anticipate some change in swimming patterns. Some sea turtles may approach the active airgun array to closer proximity, but we expect them to eventually turn away in order to avoid the active airgun array. As such, we expect only temporary displacement of exposed individuals from some portions of the action area as seismic vessels transit through.

Non-auditory Physical and Physiological Responses

Direct evidence of seismic sound causing stress is lacking in sea turtles. However, animals often respond to anthropogenic stressors in a manner that resembles a predator response (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill et al. 2001; Harrington and Veitch 1992; Harris et al. 2018; Lima 1998; Romero 2004). As predators generally induce a stress response in their prey (Dwyer 2004; Lopez and Martin 2001; Mateo 2007), we assume that sea turtles may experience a stress response if exposed loud sounds from airgun arrays. We expect breeding adult females may experience a lower stress response, as female loggerhead, hawksbill, and green turtles appear to have a physiological mechanism to reduce or eliminate hormonal response to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared with males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004).

9.2.2.3 Cetacean and Sea Turtle Prey

Seismic surveys may also have indirect, adverse effects on ESA-listed cetaceans and sea turtles by affecting their prey (including larval stages) through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution (Webster et al. 2018). Such prey include fishes (fin, sei, and sperm whales), zooplankton (blue, fin, sei, and North Atlantic right whales, as well as sea turtles), cephalopods (sperm whales), and other invertebrates such as crustaceans, molluscs, and jellyfish (sea turtles). In a recent, fairly exhaustive review, Carroll et al. (2017) summarized the available information on the impact seismic surveys have on fishes and invertebrates. In many cases, species-specific information on the prey of ESA-listed cetaceans and sea turtles is not available. Until more specific information becomes available, we expect that the prey of ESA-listed cetaceans and sea turtles would respond to sound associated with the proposed action in a similar manner to those fishes and invertebrates described below [information derived from Carroll et al. (2017) unless otherwise noted].

Like with cetaceans and sea turtles, it is possible that seismic surveys could cause physical and physiological responses, including direct mortality, in fishes and invertebrates. In fishes, such responses appear to be highly variable, and depend on the nature of the exposure to seismic activity, as well as the species in question. Current data indicate that possible physical and physiological responses include hearing threshold shifts, barotraumatic ruptures, stress responses, organ damage, and/or mortality. For invertebrates research is more limited, but the available data suggest that exposure to seismic activity could result in anatomical damage and mortality in some cases. In crustaceans and bivalves, there are mixed results with some studies suggesting that seismic surveys do not result in meaningful physiological and/or physical effects, while others indicate such effects may be possible under certain circumstances. Furthermore, even within studies there are sometimes differing results depending on what aspect of physiology one examines (e.g., Fitzgibbon et al. 2017). In some cases, the discrepancies likely relate to differences in the contexts of the studies. For example, in a relatively uncontrolled field study Parry et al. (2002) did not find significant differences in mortality between oysters that were exposed to a full seismic air gun array and those that were not, but a recently study by Day et al. (2017) in a more controlled setting did find significant differences in mortality between scallops exposed to a single airgun and a control group that received no exposure. However, the increased mortality documented by Day et al. (2017) was not significantly different from the expect natural mortality. All available data on echinoderms suggests they exhibit no physical or physiological responses to exposure to seismic activity. Based on the available data, as reviewed by Carroll et al. (2017), we assume that some fishes and invertebrates may experience physical and physiological effects, including mortality, but in most cases, such effects are only expected at relatively close distances to the seismic source. However, as noted previously in Section 7.1.5.5, recent evidence indicates that seismic airguns may lead to significant mortality of zooplankton out to approximately 1.2 km (McCauley et al. 2017).

The prey of ESA-listed cetaceans and sea turtles may also exhibit behavioral responses if exposed to active seismic airgun arrays. Based on the available data, as reviewed by Carroll et al. (2017), considerable variation exists in how fishes behaviorally respond to seismic activity, with some studies indicating no response and others noting startle or alarm responses and/or avoidance behavior. However, no effects to foraging or reproduction have been documented. Similarly, data on the behavioral response of invertebrates suggests that some species may exhibit a startle response, but most studies do not suggest strong behavioral responses. For example, a recent study by Charifi et al. (2017) found that oyster appear to close their valves in response to low frequency sinusoidal sounds. In addition, Day et al. (2017) recently found that when exposed to seismic airgun sounds, scallops exhibit behavioral responses such as flinching, but none of the observed behavioral responses were considered to be energetically costly. As with cetaceans and sea turtles, behavioral responses by fishes and invertebrates may also be associated with a stress response.

Based on the available data, we anticipate seismic surveys would result in a temporary and minor reduction in availability of prey for ESA-listed species near the airgun array immediately following the use of active seismic sources. This may be due to changes in prey distributions (i.e., due to avoidance) or abundance (i.e., due to mortality) or both. However, we do not expect this to have a meaningful *immediate* impact on ESA-listed cetaceans and sea turtles since as described above, we believe that in most cases, ESA-listed cetaceans and sea turtles will avoid closely approaching the seismic array when active, and as such will not be in areas where prey have been effected. However, even though we do not anticipate significant *immediate* adverse effects, this is not to say that *long-term*, aggregate effects to populations of ESA-listed species prey are not possible if one considers the combined effect of all the proposed seismic surveys in space and time. We further consider these *long-term*, aggregate effects in our risk analysis below.

9.2.3 Risk Analysis

In this, section we assess the consequences of the responses to the individuals that have been exposed, the populations those individuals represent, and the species those populations comprise. Our risk analysis assesses the combined probability of exposure (Section 9.2.1) and adverse responses (Section 9.2.2). Therefore, risk increases as the likelihood of exposure increases, the likelihood that exposure results in an adverse response increases, or both. At the individual level, we assess risk through changes in fitness using indicators such as growth, survival, and/or reproductive success. When we do not expect ESA-listed animals exposed to an action’s effects to experience a reduction in fitness, we would not expect the action to have adverse consequences on the viability of the populations to which those individuals belong or the species those populations comprise. As a result, if we conclude that ESA-listed animals are *not* likely to experience reductions in their fitness, we would conclude our assessment. If, however, we conclude that individual animals are likely to experience reductions in fitness, we would assess the consequences of those fitness reductions on the population(s) to which those individuals belong.

9.2.3.1 Cetaceans

Based on our exposure and response analyses, we expect that as a result of the proposed action, individual ESA-listed cetaceans would experience PTS, TTS, masking, behavioral changes, stress, and a reduction in prey availability, with the specific responses varying by species. Below we address whether or not such effects are likely to result in fitness consequences to individual animals. In doing so, we make full consideration of the status of the species (Section 7.2) and the environmental baseline (Section 8), as both are critical in understanding whether the particular responses described in Section 9.2.2 are likely to result in fitness consequences to individuals.

Hearing Threshold Shifts and Masking

PTS, TTS, and masking are expected to have similar effects on the biology of ESA-listed cetaceans given that they all impair animals' ability to hear. Whereas PTS and TTS impair hearing through actual impairment of animals' hearing mechanisms, masking impairs hearing through interference due to added seismic sound. While these responses are similar in the nature of their effects, an important distinction between PTS and TTS/masking is that PTS is permanent, while TTS and masking are temporary. Based on our exposure and response analyses, of the ESA-listed cetaceans considered during consultation, only baleen whales are expected to experience TTS and significant masking, and only fin whales are expected to experience PTS. Given that baleen whales rely on hearing for a multitude of life functions including communication and environmental awareness, important life functions of those animals that experience PTS, TTS, and/or masking may be affected. Of particular concern is whether or not PTS, TTS, and/or masking would significantly disrupt life functions in such a way that it could result in impacts to survival or reproduction (Nabi et al. 2018).

Since TTS and masking would only be temporary, it is important to consider the context in which animals are likely to experience TTS. Since none of the baleen whales considered during consultation are known to regularly mate within the action area and the effects of TTS and masking are expected to be temporary and only occur while animals are in the action area, we do not anticipate TTS and/or masking would have impacts to this aspect of reproduction. Masking and/or TTS may affect the survival of individuals, particularly if it interferes with their ability to forage (i.e., detect sounds from prey) or receive signals from predators or other anthropogenic threats (i.e., vessel sounds, thus increases the chances of a vessel strike). However, given the brief and temporary nature of TTS and masking that is expected to occur, and that the baleen whales considered during consultation primarily feed at northern latitudes outside of the action area, we do not anticipate any effects to juvenile or adult survival. However, TTS of a mother and/or a calf or masking of their communication signals, even if minor and temporary, could impact a calf's ability to nurse, and thus its growth and survival. This is especially true for North Atlantic right whales, as they are the only ESA-listed baleen whale known to regularly give birth in the action area.

TTS of North Atlantic right whale mothers and/or calves, or masking of their calls, could have effects on mother-calf communication and behavior. If such effects were severe enough to prevent mothers and calves from reuniting or initiating nursing, they may result in missed feeding opportunities for calves, which could lead to reduced growth, starvation, and even death. However, the available data suggests that North Atlantic right whale mother-calf pairs rarely use vocal communication on the calving grounds within the action area, perhaps because in the Southeast U.S. calf vocalizations are not yet fully developed and so the two maintain visual contact until calves are approximately three to four months of age (Parks and Clark 2007; Parks and Van Parijs 2015; Root-Gutteridge et al. 2018; Trygonis et al. 2013). Such findings are consistent with data on southern right and humpback whales, which appear to rely more on mechanical stimulation to initiate nursing rather than vocal communication (Thomas and Taber 1984; Videsen et al. 2017). When mother-calf pairs leave the calving grounds and begin to migrate to the northern feeding grounds, if they begin to rely on acoustic communication more, then any masking and/or TTS could interfere with mother-calf reunions. For example, even though humpback whales do not appear to use vocal communication for nursing, they do produce low-level vocalizations when moving that have been suggested to function as cohesive calls (Videsen et al. 2017). However, migrating individuals are only expected to be exposed for very brief periods given the constant movement of both whales and vessels (Costa et al. 2016a). Furthermore, when calves leave the foraging grounds at around four months of age, they are expected to be more robust and less susceptible to a missed or delayed nursing opportunity. As such, even if TTS and/or masking were to interfere with mother-calf communication along their migratory route, we do not anticipate that such effects would result in fitness consequences given their short-term nature.

For fin, blue, and sei whales, little information exists on where they give birth as well as on mother-calf vocalizations. As such, it is difficult to assess whether or not TTS and/or masking could significantly interfere with mother-calf communication in a way that could result in fitness consequences. Blue and sei whales are expected to be rare within the action area, with our exposure analysis only estimating a single group exposure for each G&G company. Given this low exposure, and that these species are not known to regularly give birth within the action area, we do not anticipate that TTS and/or masking would have an impact on blue and fin whale mother-calf fitness. Based on the stranding of six neonates, Hain et al. (1992) suggest that fin whale calving takes place in the mid-Atlantic region of the United States between October and January. To our knowledge, this suggestion has not been further confirmed. Nevertheless, based on these data and the greater exposure of fin whales (as compared to other ESA-listed baleen whales), we assume some mother-calf fin whale pairs may experience TTS and/or masking. Until more data are available on fin whale calving and mother-calf communication within the action area, we rely on our analysis of the effects of TTS and masking to North Atlantic right whales, which given their current status, are considered more vulnerable than fin whales. Based on this analysis, we do not believe that TTS and or masking will affect fin whale mother-calf fitness.

Unlike TTS, PTS is permanent meaning the effects of PTS last well beyond the duration of the proposed action and outside of the action area as animals migrate. As such, PTS of fin whales has the potential to affect aspects of their life functions that do not overlap in time and space with the proposed action. While hearing loss in fin whales resulting from temporary exposure to PTS-causing sound levels is expected to be minor and not deafen fin whales, we expect it would have some affect the hearing ability of fin whales in the frequencies of the sound that caused the damage. For airgun sounds, the main energy that would produce PTS is between 10 and 2,000 Hz (primarily below 200 Hz), depending on the proximity of an animal to the airguns. Hearing loss at these lower frequencies may interfere with fin whales ability to hear lower frequency sounds produced by ships, construction activities, seismic surveys, or communication signals of conspecifics. The ability to detect human sounds may be important to provide information of the location and direction of human activities, and may provide a warning of nearby activities that may be hazardous. The ability to detect conspecifics may be important for mating and mother-calf communication as discussed above with TTS. Given this, permanent hearing impairment has the potential to affect individual fin whale survival and reproduction, although data are not readily available to evaluate how permanent hearing threshold shifts directly relate to individual fin whale fitness. Our exposure and response analyses indicate that only 14 fin whales would experience PTS and this PTS is expected to be minor. With this expected low exposure and minor hearing impairment, even if several individual fin whales experience a minor reduction in fitness, we would not expect such impacts to have meaningful effects at the population level.

Behavioral Responses

While a great deal of research has focused on the behavioral responses cetaceans exhibit to anthropogenic sound such as that produced by seismic surveys, there is still considerable uncertainty as to whether or not such responses have consequences for fitness. However, this is not to say that studies have not investigated the possibility of such links. For example, Johnson et al. (2007) reported that foraging gray whales exposed to airgun sounds during seismic surveys off Sakhalin Island, Russia, did not experience any biologically significant or population level effects, based on subsequent research in the area from 2002 through 2005. For the same population, Cooke et al. (2015) documented a reduction in calf survival that they suggested may be related to disruption of foraging from seismic activity and pile driving. However, a more recent analysis invalidated these findings, as those calves that were assumed dead in the 2015 study, have since been observed alive elsewhere (Cooke et al. 2017). These findings by Cooke et al. highlight the importance of long-term monitoring studies, but also indicate that it will likely be decades until we are able to fully document and understand the fitness consequences of disturbance on wild populations of cetaceans. Nonetheless, as noted in Section 9.2.2.1, bowhead whales in some areas have been regularly exposed to seismic activity for decades, and despite this, continue to use these areas and experience population growth (Givens et al. 2013; Malme et al. 1984; Richardson et al. 1986)

In the absence of direct, longitudinal data, the scientific community has focused on understanding the population consequences of disturbances (PCoD) such as anthropogenic sound using various modelling approaches (NAS 2017; Pirotta et al. 2018a). The general approach is to examine if a behavioral response may lead to a change in an individual's health, and if so, estimate any reduction in individual fitness, and ultimately model the impact of such a reduction on the population as a whole (New et al. 2014). While behavioral responses can have direct impacts on fitness aside from affecting health (e.g., stranding), based on our response analysis we do not expect such direct impacts to fitness to occur. Accordingly, our risk analysis for cetaceans focuses on whether or not the behavioral responses described in Section 9.2.2.1 are expected to have effects on the health of any individual ESA-listed cetaceans. In doing so, we incorporate what is known about the current health status of individuals when supporting data are available.

Behavioral responses may impact health through a variety of different mechanisms, but most PCoD models focus on how such responses affect an animal's energy budget (Costa et al. 2016b; Farmer et al. 2018a; Farmer et al. 2018b; Harris et al. 2018; King et al. 2015; McHuron et al. 2018; NAS 2017; New et al. 2014; Pirotta et al. 2018a; Pirotta et al. 2018b; Villegas-Amtmann et al. 2017). Responses that relate to foraging behavior, such as those that may indicate reduced foraging efficiency (Miller et al. 2009) or involve the complete cessation of foraging, may result in an energetic loss to animals. Other behavioral responses, such as avoidance, may have energetic costs associated with traveling (NAS 2017). Important in considering whether or not energetic losses, whether due to reduced foraging or increased traveling, will affect an individual's fitness is considering the duration of exposure and associated response. Nearly all studies and experts agree that infrequent exposures of a single day or less are unlikely to impact an individual's overall energy budget (Booth et al. 2016; Booth et al. 2017; Christiansen and Lusseau 2015; Farmer et al. 2018b; Harris et al. 2017; Harwood and Booth 2016; King et al. 2015; McHuron et al. 2018; NAS 2017; New et al. 2014; Pirotta et al. 2018b; Southall et al. 2007; Villegas-Amtmann et al. 2015). We recognize that aside from affecting health via an energetic cost, a behavioral response could result in more direct impacts to health and/or fitness. For example, if a whale hears seismic activity and avoids the area, this may cause it to travel to an area with other threats such as vessel traffic or fishing gear. However, we find such possibilities to be extremely remote, and so focus our risk analysis on the energetic costs associated with a behavioral response.

Of the ESA-listed cetaceans considered in this opinion, only sperm whales are expected to exhibit behavioral responses that involve foraging. As noted previously, Miller et al. (2009) showed that foraging sperm whales exposed to seismic airguns altered their dive behavior and echolocation. As such, we assume that some sperm whales exposed to the proposed action may experience changes foraging behavior that may include a reduction in foraging effort and/or efficiency. Based on our exposure analysis, we also assume that some individuals may experience a reduction in foraging on multiple days. Recently, Farmer et al. (2018b) modelled the effects of lost foraging opportunities for sperm whales that may result from seismic activity in the Gulf of Mexico. Based on their results, females with calves were most vulnerable to the impacts of lost foraging opportunities. However, the level of seismic activity in the Gulf of Mexico is much greater than that considered in this opinion. Furthermore, the results of Farmer et al. (2018b) indicate that in order for exposure to seismic activity to have a meaningful impact on mothers' energy reserves, they must be exposed for much more than a few days (e.g., once a week for 10 years), which is the most any sperm whale is expected to be exposed to in this opinion. Furthermore, the proposed sperm whale closure areas are expected to provide some refuge where sperm whales would not be exposed to seismic airgun sounds at levels that would result in a disruption in foraging behavior. As such, even though we anticipate some impact to sperm whale foraging behavior, we expect this to be minor and temporary. We expect that sperm whales would be able to quickly replace any energy lost by foraging elsewhere at a later time since they would only be exposed to seismic surveys at most several times, and infrequently. As such, the proposed action is not expected to have any effects on the fitness of individual sperm whales.

As mentioned previously, none of the baleen whales are thought to regularly feed within the action area. Little is known about blue, fin, and sei whale behavior within the action area, but these species typically feed at higher latitudes. Fin whales off the west coast of the United States have been known to exhibit residency and may feed in lower latitudes year round (Scales et al. 2017). However, the oceanographic conditions off the west coast of the United States are substantially different compared to those within the action area. In particular, strong upwelling in the California current ecosystem results in abundant prey for baleen whales that may lead some individuals to remain in the area year round. The foraging behavior of North Atlantic right whales has been extensively studied, and all data indicate they feed north of the action area in the waters of the Northeastern United States (e.g., Gulf of Maine) and Canada (e.g., Bay of Fundy and Gulf of St. Lawrence). In summary, since the ESA-listed whale species considered in this opinion typically forage at higher latitudes, outside of the action area, the proposed action is not expected to impact any individual baleen whale's foraging behavior.

If ESA-listed cetaceans exhibit a behavioral response to seismic sound other than foraging, it may still pose some energetic cost. For example, if an animal exhibits an avoidance response, it would experience a cost in terms of the energy associated with traveling away from the acoustic source. As noted previously, bowhead and humpback whales appear to alter their migratory routes to avoid closely approaching seismic activity, and such changes, if they result in longer migrations, would come at some energetic cost to individuals. That said, migration is not considered a particularly costly activity, at least for some baleen whales. For example, in gray whales migration does not appear to have any significant energetic costs beyond those required for an individual's own maintenance since migrating gray whales travel at a speed equal to their minimum transport speed (Villegas-Amtmann et al. 2015). That is not to say that disturbance during migration cannot result in an energetic cost, especially if it significantly increases the length or duration of migration, ultimately delaying an individual's arrival to the foraging grounds.

Based on our exposure analysis, individual blue, sei, and North Atlantic right whales are expected to be exposed to seismic activity and exhibit a behavioral response on at most a single day, whereas sperm and fin whales may be exposed and respond on more than one day, but at a maximum only a few days of exposure are expected for any given individual. As with foraging sperm whales, females with calves are expected to be the most vulnerable to energetic losses, due to the cost of lactation (e.g., Christiansen et al. 2018). This is especially true for North Atlantic right whales given that many right whales appear to be in poor health (Rolland et al. 2016). While little is known about blue, fin, sei, and sperm whales in the action area, we are not aware of any evidence suggesting population-wide health declines. If a nutritionally stressed cetacean mother were to incur significant energetic costs as a result of a behavioral avoidance an acoustic stressor, it is possible that her reproduction could become delayed, as she would first need to compensate for the lost energy before sustaining another pregnancy (Nabi et al. 2018). Based on their status, only female North Atlantic right whales with calves are considered vulnerable to such impacts. However, due to the proposed North Atlantic right whale closure, the vast majority of females with calves are not expected to be exposed to seismic activity at levels that would produce a meaningful behavioral response. In fact, only four females with calves would be exposed to seismic sound above 160 dB re: 1 μPa (rms), across all five G&G companies, and this exposure is expected to be brief, lasting less than a day and in most cases only several minutes. Based on this low-level exposure, and on the fact that even for a nutritionally stressed animal a minor behavioral response that does not affect foraging is not expected to have significant energetic costs, we do not expect the proposed action to affect the health of individual North Atlantic right whales. We expect that if exposed, females with calves would exhibit avoidance behavior and move away from the seismic source. Such behavior would result in additional traveling and may lead to minor changes migratory routes. However, we do not expect such changes to have significant costs beyond those that would be required for physical maintenance.

In summary, we do not expect that the behavioral responses North Atlantic right whales may exhibit due to the proposed action would result in fitness consequences to individual animals. In addition, the behavioral responses of blue, fin, sei, and sperm whales to the proposed action are also not expected to result in fitness consequences to individual animals.

Stress

ESA-listed cetaceans are expected to experience a minor stress response if exposed to acoustic stressors associated with the proposed action. Stress is clearly linked to health and has even been linked to health in wild cetacean populations such as North Atlantic right whales (Rolland et al. 2017). As such, stress is also considered a factor in many PCoD models (NAS 2017).

Given the minor and short-term nature of the anticipated stress responses, we do not expect them to result in fitness consequences to any individual ESA-listed cetaceans. In fact, stress is an adaptive response that helps animals avoid predators and cope with environmental variability. Chronic stress, or distress, however can have significant health impacts. Based on our exposure analysis, those individual blue, North Atlantic right, and sei whales that are expected to be exposed to the proposed action, would only be exposed once across all five G&G companies, whereas individual fin and sperm whales may be exposed several times. In each case, exposure is expected to be brief lasting several minutes to no more than a day. Any stress associated with such exposures is similarly expected to be brief, with animals returning to baseline levels within hours to days. As a result, we do not expect the proposed action to result in chronic stress or have any impacts to individual cetaceans' health. Accordingly, we do not expect the stress responses of ESA-listed cetaceans to the proposed action to affect individual fitness.

Reduction in Prey Availability

The proposed action is likely to affect the availability of prey for ESA-listed cetaceans, either by reducing prey abundance or altering their distribution. The available data indicate that in most cases, such effects would be relatively local and occur close to the seismic array. However, given that the proposed tracklines cover a substantial area, it is possible that despite no *immediate* effects to ESA-listed cetaceans, who are expected to avoid areas where prey are impacted at the time of impact, there may be *long-term*, aggregate population level impacts to prey that could have indirect impacts on ESA-listed cetaceans.

In their review on the impacts of seismic activity on fishes and invertebrates, Carroll et al. (2017) also examined whether or not seismic activity was associated with population level changes in abundance by examining studies that quantified fisheries catch before and after seismic activity. While a few studies found negative effects of seismic activity on catch rates, most found no effects, and a few even found that surprisingly seismic activity lead to an increase in catch rates. Consistent with this, a recent study off the coast of Australia found that following a 2-D seismic survey six species of fish showed increase catch rates, while three species showed decreased catch rates (Bruce et al. 2018). Richardson et al. (2017) scaled up the results of McCauley et al. (2017) to examine the effects of a hypothetical seismic survey on zooplankton off the coast of Australia. Based on their results, seismic surveys had a significant impact on the abundance of zooplankton within and near the survey area, but such effects were short-lived and minimized by ocean circulation.

Based on the foraging behavior of the ESA-listed cetaceans considered in this opinion, only sperm whales are considered vulnerable to a reduction in prey availability. As the baleen whales considered in this opinion are thought to primarily feed outside of the action area, seismic activity is not expected to meaningfully alter the availability of their prey. Sperm whales feed deep in the water column, primarily on cephalopods. Given this, we do not expect their prey would be exposed to sound fields loud enough to result in injury or mortality, as these would occur closer to the surface, near the acoustic source. Furthermore, sperm whales are not considered resident to the action area and so likely have access to prey elsewhere that would not be affected by the proposed action, including in the proposed sperm whale closure areas. Thus, we do not expect the proposed action would affect the availability of prey by a magnitude significant enough to have effects on sperm whales fitness. Consequently, we find that the proposed action is unlikely to indirectly affect sperm whale fitness by altering the availability of their prey.

9.2.3.2 Sea Turtles

Based on our exposure and response analysis, we expect that as a result of the proposed action, individual ESA-listed sea turtles would experience TTS, behavioral changes, stress, and a reduction in prey availability. Below we summarize whether or not such effects are expected to affect the fitness of individual sea turtles. Compared to cetaceans, much less data exist on how anthropogenic sound may impact sea turtles, let alone their fitness. However, nearly all data that do exist suggest that sea turtles are much less sensitive to anthropogenic sound than cetaceans (Gomez et al. 2016; Nelms et al. 2016; Nowacek et al. 2007; Popper et al. 2014; U.S. Navy 2017a). This may be in part because sea turtles appear to be less reliant on sound than cetaceans. Below we summarize the risk these exposures and responses present to individual sea turtles.

Hearing Threshold Shifts

We anticipate that like some ESA-listed baleen whales, some sea turtles would experience TTS as a result of being exposed to the proposed action. However, we do not expect this to result in fitness consequences. Sea turtles are not known to use sound for communication, so TTS would not affect their communication. While TTS could impair sea turtles' ability to detect environmental cues such as waves crashing, wind, and predators, any such impairment is expected to be brief, with turtles recovering normal hearing within hours to days. Thus, given that sea turtles are not particularly reliant on sound and that TTS would only result in short-term hearing impairment, we do not expect TTS to affect the fitness of individual sea turtles.

Behavioral Responses

As a result of the proposed action, sea turtles are expected exhibit changes in behavior. In most cases, we expect such changes to involve altered orientation and swimming, with some sea turtles approaching seismic arrays, and others swimming away from seismic activity. However, in all cases we expect such behaviors to be temporary, lasting as long as the exposure (less than a day, in most cases likely only minutes) or slightly longer. As with cetaceans, behavioral responses are not expected to directly result in fitness consequences (e.g., turtle avoiding area with seismic activity and incidentally moving into an area with predators), as we find the likelihood of such possibilities to be extremely low. Our greatest concern would be if behavioral responses resulted in energetic costs that could impact survival or reproduction. However, we do not expect that a short-term response involving changes in swimming would have any meaningful impact on an individual sea turtle's energy budget. We base this in part on our analysis for cetaceans (e.g., North Atlantic right whale mothers), who are expected to be much more energetically stressed when compared to sea turtles. Furthermore, we assume that sea turtles, like all animals, are capable of enduring some level of environmental variability (e.g., storms, changes in currents, a passing whale) and do not expect that behavioral responses to seismic activity would have an impact any greater than responses to natural occurring phenomena, which sea turtles should be able to cope with, without any effects to fitness. Thus, we do not expect sea turtles to experience a reduction in fitness due to changes in behavior that may result from exposure to seismic surveys.

Stress

To our knowledge, there is no direct evidence indicating that sea turtles will experience a stress response if exposed to seismic activity. Nevertheless, based on other species' responses to anthropogenic stressors, including those of cetaceans to anthropogenic sound, we assume that some sea turtles will exhibit a stress response if exposed to seismic activity. However, we expect such responses to be brief, with animals returning to a baseline state within hours to days. As with cetaceans, such a short, low-level stress response may in fact be adaptive and beneficial as it may result in sea turtles exhibiting avoidance behavior, thereby minimizing their exposure to higher sound levels. Regardless, given that stress responses are expected to be minor and short-term, we do not anticipate that they would impact the fitness of any individual sea turtle.

Reduction in Prey Availability

As noted previously, seismic surveys may result in an *immediate* reduction in prey, especially near the active acoustic source, which could impact ESA-listed sea turtles. Reductions in availability may be due to changes in prey abundance, distribution, or both. Based on the available data, as reviewed in Carroll et al. (2017), there is mixed evidence as to whether or not seismic activity has meaningful *long-term* impacts at the population level for sea turtle prey. However, most studies found no population level effects, and some even found an increase in prey catch following seismic activity. The recent study by McCauley et al. (2017) suggests that in some cases, seismic activity may have substantial impacts to zooplankton, which could impact neritic juvenile sea turtles. However, as alluded to in Section 7.1.5.5, such impacts are expected to be temporary and not have enough of an impact that they would result in a reduction of grown and survival for sea turtles. Furthermore, a recent study by Richardson et al. (2017) that applied the results of McCauley et al. (2017) to a hypothetical full scale seismic survey, found the effects of seismic activity were limited to relatively close to the survey footprint (15 km) and that ocean circulation minimized the overall effect seismic activity had on zooplankton abundance in the ecosystem. Thus, based on the current data we expect a minor reduction in the availability prey of ESA-listed sea turtles, but we do not expect this to have an effect on the fitness of any individual sea turtle.

9.3 Effects of Changes to Spectrum's Tracklines

Following receipt of the requests from BOEM and the Permits and Conservation to change their proposed actions to incorporate the modified Spectrum tracklines, we evaluated the potential effect of these changes in terms of their effect on exposure (i.e., Section 9.2.1) since the modified tracklines are not expected to result in any change in response (i.e., Section 9.2.2) given that the same acoustic source would be used.

Considering that the modified tracklines would result in an overall decrease in survey effort by approximately 36 percent, and that the same acoustic source would be used, our exposure analysis of the potential for PTS of blue whales, North Atlantic right whales, sei whales, and sea turtles remains the same and, therefore, we do not expect any PTS of these species. For PTS exposure of fin whales, the reduction in total survey line reduces the expected number of instances of PTS exposure of fin whales. The total amount of survey line in Spectrum's modified survey plan is similar to that proposed by ION, and, in fact, the distance to the PTS threshold for Spectrum for low-frequency cetaceans is slightly smaller than it is for ION (Table 11). Therefore, we adopted the logic presented previously for ION in revising our estimate for the number of PTS exposures for fin whales (see Section 9.2.1 for more detail).

For evaluating the effect of Spectrum's modified tracklines on the expected exposure for harassment (behavioral harassment and TTS), we used spatial analyses to estimate the potential change in exposure that may result from the modified tracklines compared to the original tracklines (see Figure 32). Given that for sea turtles and North Atlantic right whales we conducted our own exposure analysis (sea turtles) or worked directly with the Permits and Conservation Division to estimate exposure (North Atlantic right whales), for these species we followed an identical process to that previously described in Section 9.2.1 to re-estimate exposure that would result in harassment. For blue and sei whales, we retained the original exposures estimates of single group of animals as the change in tracklines is not expected to significantly change the likelihood of harassment of a single group of each of these species. For harassment of fin and sperm whales, our exposure estimates based on Spectrum's original tracklines relied on the acoustic modeling and exposure estimates produced by Marine Acoustics, Inc. in Spectrum's IHA application, with adjustments made to incorporate new information from Roberts et al. (2016) on species density and to account for time/area closures (see Section 9.2.1.1). In order adjust these previous exposure estimates to account for the modified tracklines, while retaining the activity specific (e.g., acoustic source characteristics) properties of the previous exposure analysis, we relied on a relative approach in which we compared fin and sperm whale densities within an assumed ensonified area [based on the radii to the 160 dB re: 1 μPa (rms) threshold (95 percent range, see Appendix D, Table D-22 in BOEM

(2014a)] associated with the original survey tracklines and associated with the modified survey tracklines. This allowed us to calculate a ratio of the expected exposures that would result in harassment from the modified tracklines compared to the original tracklines and, therefore, to evaluate the degree of change in terms of exposure. Note that in conducting this evaluation, we used mean fin and sperm densities over the 21 modeling areas or zones [extracted from Roberts et al. (2016) within the acoustic modeling regions specified in BOEM's 2014 PEIS, see Appendix E, Table E-5 and Figures E-11 to E14 in BOEM (2014a)] according to the operating window proposed by Spectrum, as previously described in Section 9.2.1. Detailed steps to the evaluation are as follows:

1. Obtain trackline lengths for each relevant season and zone for original and modified Spectrum tracklines;
2. Multiply trackline lengths by mean buffer widths based on the distance to the 160 dB re: 1 μPa (rms) threshold for each zone to get the area surveyed for both original and modified tracklines;
3. Multiply above areas by zone specific species densities to obtain raw exposure estimates by zone for original and modified tracklines for each species (accounting for Spectrum's operating window and implementation of applicable time/area closures);
4. Calculate the ratio of the expected exposure from the modified tracklines to the original tracklines;
5. Multiply the above ratio by the original exposure estimates based on the original tracklines (i.e., those detailed in Section 9.2.1.1) to obtain revised exposure estimates based on the modified tracklines.

The complete results of our evaluation of Spectrum's modified tracklines, compared to their original tracklines, in terms of exposures estimates are shown in Table 17 below.

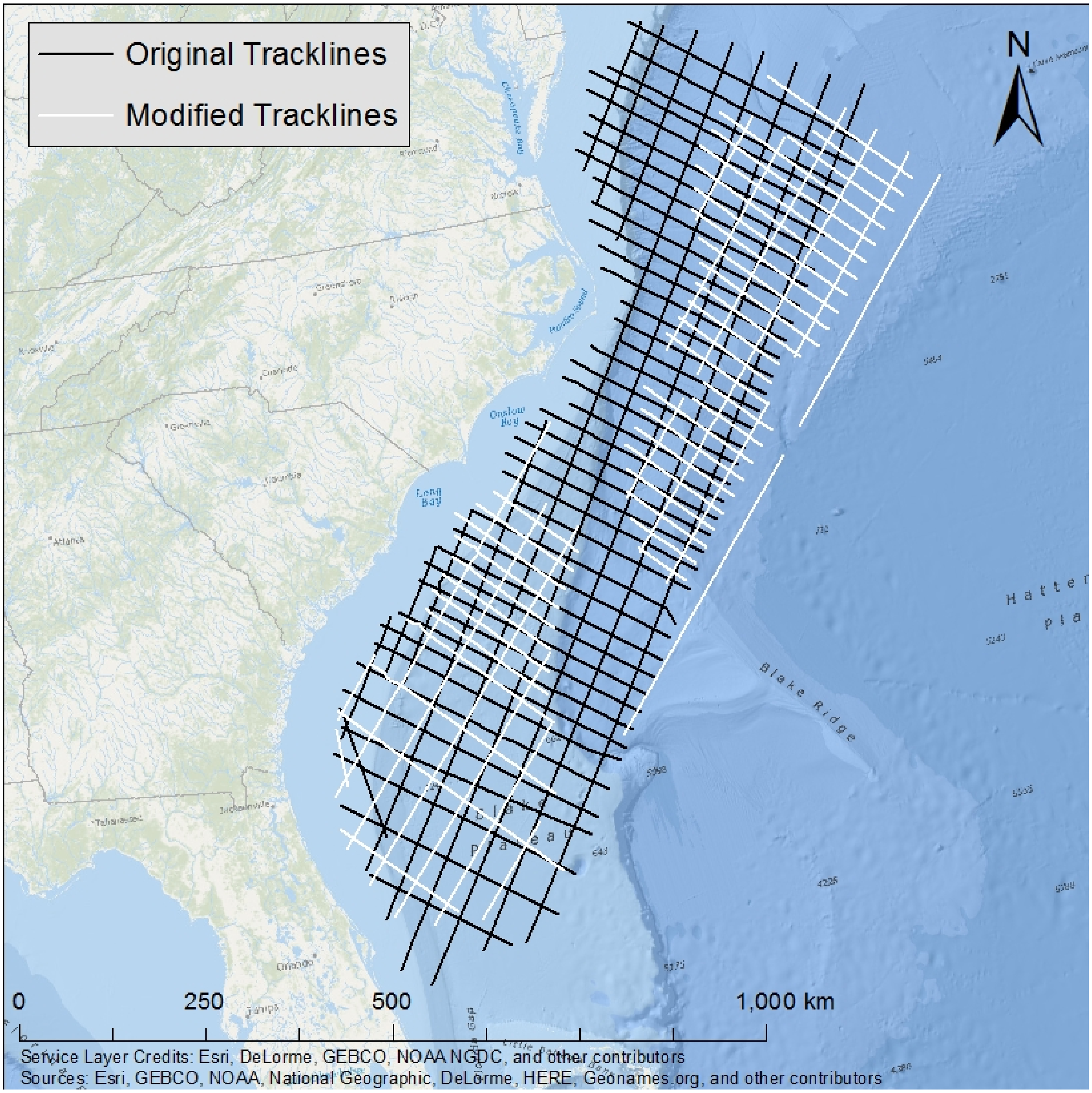

Figure 32. Modified Spectrum tracklines (white) overlaid on original tracklines (black).

Table 17. Estimated exposure for original and modified Spectrum tracklines.

Species/Guild	Original Spectrum Tracklines		Modified Spectrum Tracklines		Reduction in Exposure	
Cetaceans	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	-	6	-	2	-	67%
Sei whale	-	2	-	2	-	-
Fin whale	4	333	2	163	50%	51%
Blue whale	-	1	-	1	-	-
Sperm whale	-	1,077	-	684	-	36%
Sea Turtles	**Harassment**		**Harassment**		**Harassment**	
	(TTS)	**(Behavior)**	**(TTS)**	**(Behavior)**	**(TTS)**	**(Behavior)**
Hardshell (loggerhead, green, or Kemp's ridley)	1,650	5,657	915	3,139	45%	45%
Kemps ridley	217	755	93	324	57%	57%
Leatherback	1,514	5,158	1,014	3,467	33%	33%
Loggerhead (Northwest Atlantic DPS)	2,135	7,394	1,167	4,007	45%	46%
Ensonified Area for Small Sea Turtles (km^2)	23,916	81,664	14,846	50,902	38%	38%

As can be seen in Table 17, Spectrum's modified tracklines are expected to result in an overall decrease of exposure for all ESA-listed species, with the reduction in exposure ranging from 33 to 67 percent depending on the species and the type of exposure. As noted earlier, the modification of Spectrum's tracklines is not expected to result in any changes in response. Thus, our response analysis for Spectrum's modified tracklines remains the same as that previously described in Section 9.2.2.

In our risk analysis (Section 9.2.3), which assessed the combined probability of exposure (based on the original Spectrum tracklines) and adverse responses, we found that proposed action is not expected to affect the fitness of individual blue whales, North Atlantic right whales, sei whales, sperm whales, or sea turtles, and is only expected to have minor effects on the fitness of several individual fin whales. Relying on the updated exposure estimates based on Spectrum's modified tracklines does not change our risk analysis for blue whales, North Atlantic right whales, sei whales, sperm whales, or sea turtles given that for these species, no effects to fitness are expected. For fin whales, the lower exposure associated with the modified tracklines is expected to further reduce the number of fin whale individuals that would experience minor effects on fitness.

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 C.F.R. §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

This section attempts to identify the likely future changes and their impact on ESA-listed species and their critical habitats in the action area. This section is not meant to be a comprehensive socio-economic evaluation, but a brief outlook on future changes in the environment. Projections are based upon recognized organizations producing best-available information and reasonable rough-trend estimates of change stemming from these data. However, all changes are based upon projections that are subject to error and alteration by complex economic and social interactions.

During this consultation, we searched for information on future state, tribal, local, or private (non-Federal) actions reasonably certain to occur in the action area. We did not find any information about non-Federal actions other than what has already been described in the *Environmental Baseline* (Section 8), most of which we expect will continue in the future. An increase in these activities could similarly increase their effect on ESA-listed cetaceans and sea turtles and for some, an increase in the future is considered reasonably certain to occur. Given current trends in global population growth, threats associated with climate change, pollution, fisheries, bycatch, aquaculture, vessel strikes and approaches, and sound are likely to continue to increase in the future, although any increase in effect may be somewhat countered by an increase in conservation and management activities. In contrast, more historic threats such as whaling and sea turtle harvest are likely to remain low or potentially decrease. For the remaining activities and associated threats identified in the *Environmental Baseline*, and other unforeseen threats, the magnitude of increase and the significance of any anticipated effects remain unknown. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on sea turtle and cetacean populations. Thus, this consultation assumed effects in the future would be similar to those in the past and, therefore, are reflected in the anticipated trends described in the status of the species (Section 7.2) and *Environmental Baseline* sections.

11 Integration and Synthesis

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 9) to the *Environmental Baseline* (Section 8) and the

Cumulative Effects (Section 10) to formulate the agency's opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of each ESA-listed species (Section 7.2). In our analysis of the *Effects of the Action*, we relied primarily on the tracklines provided in the original proposed IHA and BOEM permit for Spectrum, not those provided in Spectrum's request to modify their proposed tracklines on June 4, 2018. Since our *Integration and Synthesis* relies on our analysis of the *Effects of the Action*, it too relies primarily on the original Spectrum tracklines. However, we evaluated whether Spectrum's modified tracklines would alter our effects analysis (see Section 9.3) and incorporate that information here as appropriate.

As discussed in Section 3.7, as part of the proposed action BOEM and the Permits and Conservation Division propose several conservation measures. These include time/area closures, seismic survey protocols, and vessel strike avoidance and marine debris awareness measures. Because we anticipate these conservation measures will be implemented and effective, we make full consideration of them in our *Integration and Synthesis*. As noted throughout below, our analyses and conclusions are predicated on these measures being implemented.

Several ESA-listed species and designated critical habitat occur within the action area and either are not expected to be affected by the proposed action or may be affected by the proposed action but are not likely to be adversely affected because the effects of the proposed action are insignificant or discountable (Section 7.1). These include: Atlantic sturgeon (Carolina, Chesapeake Bay, Gulf of Maine, New York Bight, and South Atlantic DPSs), Giant manta rays, oceanic whitetip sharks, hawksbill sea turtles, Atlantic sturgeon designated critical habitat (Carolina, Chesapeake Bay, New York Bight, and South Atlantic DPSs), loggerhead sea turtle designated critical habitat (Northwest Atlantic Ocean DPS), and North Atlantic right whale designated critical habitat. In addition, the following stressors associated with the proposed action were determined not likely to adversely affect any of the ESA-listed species considered in this opinion because their effects are insignificant or discountable: pollution, vessel strikes, vessel disturbance, aircraft disturbance, echosounders, and entanglement. In many cases, such determinations were influenced by the proposed conservation measures. For example, the proposed North Atlantic right whale closure would provide substantial protection for Atlantic sturgeon (all DPSs), and the proposed vessel strike avoidance measures would reduce the probability of a vessel strike.

The remaining ESA-listed species considered in this opinion (cetaceans and sea turtles) may be affected, and are likely to be adversely affected by the proposed action as a result of sound from seismic airguns. The status of each of these species, as described in Section 7.2, varies greatly. Little is known about the blue whale population that may be found within the action area, but worldwide the species is showing signs of recovery, with some populations increasing in size. Similarly, fin whales are not well studied within the action area but globally, there are several large, growing populations. In general, sei whales are a poorly studied species. Existing estimates indicate most populations are small, and population trends are unknown. Sperm whales are likely one of the most abundant large whale species and globally are showing strong signs of recovery. In contrast, North Atlantic right whales have a limited distribution, small and declining population, and some evidence suggests the overall health of the population is poor. The North Atlantic DPS of green sea turtles appears to be large and increasing. The Northwestern Atlantic Ocean DPS of loggerheads sea turtles is also relatively large, but several lines of evidence suggest it is currently experiencing a decline. Leatherback sea turtles in the Atlantic Ocean appear to be recovering to some degree. Overall, the species abundance is still relatively low compared to other sea turtles, but in the Atlantic, the population appears to be increasing. Kemp’s ridley sea turtles were one of the most decimated sea turtle species. While recent evidence suggest the species abundance is increasing, their limited range and low global abundance still put them at risk.

A variety of current and past anthropogenic threats impact the ESA-listed cetacean and sea turtles within the action area including climate change, invasive species, pollution, fisheries, bycatch, aquaculture, whaling, sea turtle harvest, scientific research, vessel strikes, vessel approaches, and sound. Most of these activities are expected to continue into the future to some degree, but the magnitude at which, and their future impacts on the survival and recovery of ESA-listed species is not reliably predictable.

Considering the proposed time/area closures, across all IHAs and permits a relatively small percentage (approximately 10 percent or less) of the populations of North Atlantic right whales, sei whales, blue whales, green sea turtles, and Kemp’s ridley sea turtles that occur within the action area are expected to be exposed to active acoustic sources associated with the proposed action at a level that may result in adverse effects. In contrast, a higher percentage (approximately 11 percent to 59 percent) of the populations of fin whales, sperm whales, loggerhead sea turtles, and leatherback sea turtles that may be found within the action area are expected to be exposed to the active acoustic sources associated with the proposed action at a level that may result in adverse effects. Due to animal and vessel movement, and the proposed seismic survey protocols, these exposures are expected to be brief (less than a day), and except for fin and sperm whales, individuals are not expected to be exposed more than once across all five IHAs/permits. Based on the best available data, blue, North Atlantic right, and sei whales are expected to experience minor and temporary hearing threshold shifts, masking, and behavioral and stress responses, fin whales are expected to experience minor temporary and permanent hearing threshold shifts, and minor and temporary masking and behavioral and stress responses, sperm whales are expected to experience minor and temporary behavioral and stress responses, and sea turtles are expected to experience minor and temporary hearing threshold shifts and behavioral and stress responses. In addition, the proposed action is expected to result in a minor and temporary reduction in the availability of prey for sperm whales and sea turtles.

Based on our risk analysis, which assessed the combined probability of exposure and adverse responses, the proposed action is not expected to affect the fitness of individual blue whales, North Atlantic right whales, sei whales, sperm whales, or sea turtles, and is only expected to have minor effects on the fitness of several individual fin whales. Of the cetaceans considered in this consultation, North Atlantic right whales are at greatest risk given their current status. The proposed North Atlantic right whale closure greatly limits the exposure of North Atlantic right whales, and given the expected responses, it is highly unlikely that any individual North Atlantic right whale would experience a reduction in fitness as a result of the proposed action. Blue and sei whale exposure is also expected to be low, and given what is known about their status and how they are likely to respond to the proposed action, blue and sei whales are also not expected to experience a reduction in fitness. While a larger number of sperm whales are expected to be exposed to sound levels that would result in behavioral harassment, the proposed sperm whale closures would limit this species overall exposure (e.g., reduced by approximately four percent compared to no sperm whale closures), and based on what is known about the status of sperm whales, they too are not expected to experience a reduction in fitness as a result of the proposed action. Like sperm whales, a greater numbers of fin whales are expected to be exposed to sound levels that would result in behavioral harassment. In addition, 14 fin whales are expected to experience minor permanent hearing loss. While we do not expect behavioral harassment of fin whales to result in fitness consequences to any individual, it is possible that minor permanent hearing loss may affect the fitness of individual fin whales. However, the proposed seismic survey protocols would minimize the severity of permanent hearing loss in fin whales, and even if several individuals experience a minor reduction in fitness, we do not expect that this would affect the viability of the population to which those fin whales belong. Finally, while sea turtle exposure varies by species, several of the proposed closure (e.g., Coastal Closure, North Atlantic right whale closure) would limit sea turtle exposure, and sea turtles are not expected to be particularly sensitive to seismic airgun sounds. No sea turtles are expected to experience a reduction in fitness as a result of the proposed action.

Considering the proposed conservation measures, the activities to which ESA-listed cetacean and sea turtles within the action areas are likely to be exposed, their potential responses to these activities, the status of each species, and their current environmental baseline, we determined that the proposed action would result in minor permanent hearing threshold shifts (fin whales only), temporary hearing threshold shifts and minor and temporary masking, behavioral responses, and stress responses, as well as a minor reduction in the availability of prey. We find that the proposed action is not likely to result in negative consequences to the fitness of any individual blue whale, North Atlantic right whale, sei whale, sperm whale, or sea turtle, and therefore, it is also unlikely to have any population-level consequences for these species. While it is possible that the proposed action will have minor effects on the fitness of several fin whales, it is not expected to have any population-level consequences for this species. As such, the proposed action is not likely to reduce appreciably the likelihood of the survival and recovery of any ESA-listed species in the wild by reducing its numbers, reproduction, or distribution. As it was determined that the proposed action would either have no effect or is not likely to adversely affect all designated critical habitat considered in this consultation, it is also not likely to reduce the value of any designated critical habitat for the conservation of any ESA-listed species.

In addition, we have considered the implications of Spectrum's modified tracklines on our *Integration and Synthesis*. In our analysis of the *Effects of the Action* (see Section 9.3) we found that the modified tracklines largely remain within the footprint of the original tracklines, with the most notable change being the reduction of total survey line and the removal of survey line from certain areas within that footprint, including, the total removal of many lines from within some of the proposed time-area closures. These changes resulted in an overall reduction in exposure to ESA-listed species ranging from 33 to 67 percent depending on the species and the type of exposure. No changes in responses are expected given that the same acoustic source would be used. The modified tracklines had no effect on our risk analysis for blue whales, North Atlantic right whales, sei whales, sperm whales, or sea turtles given that for these species, no effects to fitness are expected. For fin whales, the modified tracklines are expect to reduce the number of fin whale individuals that would experience minor effects on fitness. As described above, based on Spectrum's original tracklines, we determined that (1) the proposed action is not likely to reduce appreciably the likelihood of the survival and recovery of any ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; and (2) that the proposed action would is not likely to reduce the value of any designated critical habitat for the conservation of any ESA-listed species. Based on our evaluation of Spectrum's modified tracklines, which in all cases reduce impacts to ESA-listed species, we affirm that these conclusions remain valid.

12 Conclusion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is the NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence or recovery of blue whales, fin whales, North Atlantic right whales, sei whales, sperm whales, green sea turtles (North Atlantic DPS), Kemp's ridley sea turtles, leatherback sea turtles, and loggerhead sea turtles (Northwest Atlantic Ocean DPS). We find that the proposed action is not likely to adversely affect hawksbill sea turtles, Atlantic sturgeon (Carolina, Chesapeake Bay, Gulf of Maine, New York Bight, and South Atlantic DPSs), giant manta rays, and oceanic whitetip sharks; thus, it is also not likely to jeopardize the continued existence or recovery of these species.

We find that the proposed action is also not likely to adversely affect designated critical habitat for loggerhead sea turtles (Northwest Atlantic Ocean DPS) and will have no effect on designated critical habitat for North Atlantic right whales; thus, no destruction or adverse modification of the designated critical habitat for these species is anticipated. Critical habitat for Atlantic Sturgeon (Carolina, Chesapeake Bay, Gulf of Maine, New York Bight, and South Atlantic DPSs), hawksbill sea turtles, green sea turtles (North Atlantic DPS), and leatherback sea turtles has been designated. However, the proposed action will have no effect on the designated critical habitat for these species since they fall outside the action area; thus, no destruction or adverse modification of the designated critical habitat for these species is anticipated. Finally, no critical habitat has been designated for giant manta rays, Kemp's ridley sea turtles, blue whales, fin whales, sei whales, or sperm whales; therefore, no critical habitat will be affected for these species.

13 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct" (16 U.S.C. §1532(19)). "Harm" is further defined by regulation to include significant habitat modification or degradation that results in death or injury to ESA-listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 C.F.R. §222.102). NMFS had not yet defined "harass" under the ESA in regulation, but has issued interim guidance on the term "harass," defining it as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering." Under the MMPA, Level A harassment is defined as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild" (16 U.S.C. §1362(18)(A)(i)). Under the MMPA, Level B harassment is defined as "any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (16 U.S.C. §1362(18)(A)(ii)). For purposes of this consultation, we relied on the MMPA definition of Level B harassment to estimate the number of instances of ESA take of ESA-listed marine mammals by harassment and equate instances of MMPA Level A harassment to instances of harm of ESA-listed marine mammals under the ESA. For sea turtles, we considered NMFS' interim definition of harassment in evaluating whether the proposed activities are likely to harass ESA-listed sea turtle species. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

Under the terms of Section 7(b)(4) and 7(a)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such talking is in compliance with the terms and conditions of this incidental take statement. Further, when an action will result in take of ESA-listed marine mammals, ESA section 7(b)(4) requires that such taking be authorized under the MMPA section 101(a)(5) before the Secretary can issue an incidental take statement for ESA-listed marine mammals and that an incidental take statement specify those measures that are necessary to comply with Section 101(a)(5) of the MMPA. Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement, including those specified as necessary to comply with the MMPA, Section 101(a)(5). Accordingly, the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, this incidental take statement is inoperative for ESA-listed marine mammals.

13.1 Amount or Extent of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take specifies the impact, i.e., the amount or extent, of such incidental taking on the species and may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (see 80 FR 26832).

As noted in Section 1.1, Spectrum requested to modify their proposed tracklines on June 4, 2018, after the completion of our effects analysis for this consultation. As such, that analysis and the conclusions of this opinion relied primarily on our evaluation of the tracklines provided in the original proposed IHA and BOEM permit for Spectrum, not the modified tracklines. However, in Section 9.3, we made full consideration of how Spectrum’s modified tracklines affected exposure, and here rely on that analysis in estimating the amount or extent of take that is reasonably certain to occur.

We anticipate the proposed action is likely to result in the incidental take of ESA-listed cetaceans and sea turtles by harassment (all species) and harm (fin whales only) (Table 18 and Table 19). No death is expected for any individual cetacean or sea turtle exposed to seismic survey activities. Because our exposure analysis for cetaceans did not differentiate between TTS and behavioral harassment, we do not distinguish between these two forms of harassment in this incidental take statement. Thus, the take of cetaceans by harassment as specified in Table 18 may be in the form of either TTS or behavioral harassment. For cetaceans, such harassment is expected to occur if individuals are exposed to sound levels at or above 160 dB re: 1 µPa (rms). For fin whales, harm is expected to occur if individuals are exposed to sound levels at or above the PTS thresholds identified in Table 9. For sea turtles, behavioral harassment is expected to occur if individuals are exposed to sound levels at or above 175 dB re: 1 µPa (rms), and TTS, which is also consider harassment, is expected to occur at or above those levels specified in

Table 13. As noted in our exposure analysis, some sea turtle take estimates could not be made to species, and instead were classified as being of hardshell turtles as a group. Based on the best available data, we expect that the majority of these unidentified hardshell turtles will be loggerhead turtles (Northwest Atlantic Ocean DPS), with the remainder representing green (North Atlantic DPS) and Kemp's ridley turtles.

Table 18. Estimated amount of incidental take of Endangered Species Act-listed cetaceans and sea turtles (excluding sea turtles less than 30 centimeters) authorized by this incidental take statement. For sea turtles, our analysis allows for further delineation of the estimated incidental takes by harassment into behavioral harassment and temporary hearing threshold shifts (TTS). Such delineation was not possible for marine mammals based on our exposure analysis. Only fin whales are estimated to be taken by harm due to permanent threshold shifts (PTS).

Species/Guild	ION		Spectrum		TGS		WesternGeco		CGG		Total	
Cetaceans	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**	**Harm (PTS)**	**Harassment (TTS/Behavior)**
North Atlantic right whale	-	2	-	2	-	9	-	4	-	2	-	19
Sei whale	-	2	-	2	-	2	-	2	-	2	-	10
Fin whale	2	3	2	163	4	1,140	-	537	4	45	12	1,888
Blue whale	-	1	-	1	-	1	-	1	-	1	-	5
Sperm whale	-	16	-	684	-	3,579	-	1,941	-	1,304	-	7,524
Sea Turtles	**Harassment (TTS)**	**Harassment (Behavior)**	**Harassment (TTS)**	**Harassment (Behavior)**	**Harassment (TTS)**	**Harassment (Behavior)**	**Harassment (TTS)**	**Harassment (Behavior)**	**Harassment (TTS)**	**Harassment (Behavior)**	**Harassment (TTS)**	**Harassment (Behavior)**
Hardshell (loggerhead, green, or Kemp's ridley)	1,717	7,823	915	3,139	2,450	12,849	-	2,388	1,265	4,338	6,347	30,537
Kemps ridley	159	735	93	324	215	1,128	-	473	60	204	527	2,864
Leatherback	1,035	4,712	1,014	3,467	1,678	8,770	-	3,272	2,193	7,529	5,920	27,750
Loggerhead (Northwest Atlantic DPS)	2,522	11,533	1,167	4,007	3,594	18,901	-	3,980	1,988	6,819	9,271	45,240

Where it is not practical to quantify the number of individuals that are expected to be taken by the action, a surrogate (e.g., similarly affected species, habitat, ecological conditions, and sound pressure thresholds) may be used to express the amount or extent of anticipated take (50 C.F.R. §402.14(i)(1)(i)). Because there are no reliable estimates of small sea turtles (less than 30 cm) within the action area, we were unable to estimate the number of small sea turtles that would be taken by harassment as a result of the proposed action. As such, we rely on the extent of the ensonified areas in which small sea turtles would be exposed to sound fields that would result in harassment (behavioral or TTS) (Table 19). Any small turtles found within these ensonified areas are expected to be taken in the form of harassment during airgun array operations. The majority of these small sea turtles are expected to be associated with *Sargassum* habitat within the ensonified areas.

Table 19. Estimated amount of take by harassment (measures as ensonified area) of Endangered Species Act-listed sea turtles less than 30 centimeters in diameter authorized by this incidental take statement.

Company	TTS Ensonified Area (km²)	Behavioral Harassment Ensonified Area (km²)
ION	18,508	84,485
Spectrum	14,846	50,902
TGS	32,035	167,912
WesternGeco	-	52,758
CGG	32,243	110,609
Total	**97,632**	**466,666**

13.2 Effects of Take

In this opinion, we determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence or recovery of any ESA-listed species or result in the destruction or adverse modification of designated critical habitat. The adjusted take numbers for Spectrum based on their modified tracklines do not disturb these findings, as the adjusted amount of take will not result in any meaningful change in effect to any listed species or designated critical habitat other than reducing the overall exposure.

13.3 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by BOEM, BSEE, and the Permits and Conservation Division so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and terms and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o), of the ESA.

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02). We believe the conservation measures included as part of the proposed action (Section 3.7) will minimize the amount and extent of incidental take that may result from the proposed action. As such, the following reasonable and prudent measures are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

1. NMFS' Permits and Conservation Division must require all project-associated personnel to adhere to the description of the proposed action as described in this opinion, including the Permits and Conservation Division's proposed conservation measures. This includes requiring all seismic survey operators to abide by the time/area closures, seismic airgun survey protocols, and vessel strike avoidance measures proposed by the Permits and Conservation Division.
2. NMFS' Permits and Conservation Division must require the applicant G&G companies to monitor and report any interactions with ESA-listed marine mammals and subsequently report such interactions to NMFS' Interagency Cooperation Division.
3. BOEM, in coordination with BSEE, must require all project-associated personnel to adhere to the description of the proposed action as described in this opinion, including all proposed conservation measures. This includes requiring all seismic survey operators to abide by all time/area closures, seismic airgun survey protocols, and vessel strike avoidance and marine debris awareness measures.
4. BOEM, in coordination with BSEE, must require the applicant G&G companies to monitor and report any interactions with ESA-listed species and subsequently report such interactions to NMFS' Interagency Cooperation Division.

13.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, BOEM, BSEE, and the Permits and Conservation Division must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These include the take minimization, monitoring, and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). These terms and conditions are non-discretionary. If BOEM, BSEE, and the Permits and Conservation Division fail to ensure compliance with these terms and conditions and their associated reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

1. To implement Reasonable and Prudent Measure 1, the Permits and Conservation Division must:

   a. Condition the final IHAs with the measures specified in Section 3.7.1.1, 3.7.1.2, 3.7.1.3, 3.7.2, and 3.7.3 of this opinion and detailed in the proposed IHAs (82 FR 26244, Appendix A), as modified on the basis of public comment and during consultation.
   b. Ensure that these final IHA measures are implemented.
2. To implement Reasonable and Prudent Measure 2, the Permits and Conservation Division must:
   a. Condition the final IHAs to include the monitoring and reporting requirements as specified in the proposed IHAs (82 FR 26244, Appendix A), as modified on the basis of public comment and during consultation.
   b. Provide copies of all resulting reports to NMFS' Interagency Cooperation Division within 30 days of receipt from the IHA holders.
3. To implement Reasonable and Prudent Measure 3, BOEM, in coordination with BSEE, must:
   a. Condition the permits with all measures specified in Section 3.7 of this opinion and detailed in the final IHAs, Appendix C, Appendix D, BSEE NTL 2015-G03 (Appendix E) and applicable CZMA Conditions (Appendix B).
   b. Ensure that these permit measures are implemented.
4. To implement Reasonable and Prudent Measure 4, BOEM, in coordination with BSEE, must:
   a. Condition the permits to include the monitoring and reporting requirements as specified in Appendix C and Appendix D.
   b. Provide copies of all resulting reports (including any interim, draft, and final reports) to NMFS' Interagency Cooperation Division within 30 days of receipt from the permit holders.

14 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

We make the following conservation recommendations, which would provide information for future consultations involving the issuance of permits that may affect ESA-listed cetaceans as well as reduce harassment related to the authorized activities:

1. We recommend that BOEM consider making the voluntary turtle pause described in Section 3.7.2.3 and the turtles guards described in Section 9.1.6 requirements for all G&G permits. While we do not believe auditory injury or entanglement are likely to

result from the proposed action, these simple measures, which many G&G companies appear to already take, further reduce the likelihood of adverse effects to ESA-listed sea turtles and do not appear to affect the quality of seismic data obtained.

2. We recommend that BOEM and the Permits and Conservation Division work with the G&G companies in order to coordinate their seismic surveys such that across companies the overall impact of the seismic activity on ESA-listed species is minimized. Based on the available data, the greatest impact is expected to occur if animals are more frequently disturbed and have little time for recovery between disturbances. As such, staggering the issuance of the IHAs and permits, if allowable given the G&G companies' timelines, may reduce the overall additive impacts associated with the proposed action.
3. We recommend that BSEE and the Permits and Conservation Division work to make the data collected as part of the required monitoring and reporting available to the public and scientific community in an easily accessible online database that can be queried to aggregate data across PSO reports. Access to such data, which may including sightings as well as responses to seismic activity, will not only help us better understand the biology of ESA-listed species (e.g., their range), it will also inform future consultations and IHAs/permits by providing information on the effectiveness of the conservation measures and the impact of seismic activity on ESA-listed species.
4. We recommend that BOEM and the Permits and Conservation Division encourage the G&G companies to utilize real-time cetacean sighting services such as NMFS' North Atlantic Right Whale Sighting Survey and Early Warning System (http://sero.nmfs.noaa.gov/protected_resources/right_whale/seus_sightings/) or the WhaleAlert App (http://www.whalealert.org/). We recognize that in many cases, the companies may not have reliable internet access during operations far offshore, but nearshore, where many of the cetaceans considered in this opinion are likely found in greater numbers, we anticipate internet access would be better. Monitoring such systems would help the companies plan their surveys to avoid locations with recent ESA-listed cetacean sightings, and may also be valuable during operations to alert survey operators of cetaceans within the area, which they can then avoid.

In order for us to be kept informed of actions minimizing or avoiding adverse effects on or benefiting ESA-listed species or their critical habitat, BOEM, BSEE, and the Permits Division should notify us of any conservation recommendations they implement in their final action.

15 Reinitiation Notice

This concludes formal consultation on BOEM's and the Permits Division and Conservation Division's proposal to issue five G&G permits and IHAs respectively. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

(1) The amount or extent of taking specified in the incidental take statement is exceeded.
(2) New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
(3) The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
(4) A new species is listed or critical habitat designated under the ESA that may be affected by the action.

If the amount of tracklines, location of tracklines, acoustic characteristics of the airgun arrays, or any other aspect of the proposed action changes in such a way that the incidental take for ESA-listed species could be greater than estimated in the incidental take statement of this opinion, then (3) above may be met and reinitiation of consultation may be necessary.

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Biological Opinion on the Bureau of Ocean Energy Management's Issuance of Five Oil and Gas Permits for Geological and Geophysical Seismic Surveys off the Atlantic Coast of the United States, and the National Marine Fisheries Services' Issuance of Associated Incidental Harassment Authorizations: Appendix A

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XE283

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Geophysical Surveys in the Atlantic Ocean

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

ACTION: Notice; five proposed incidental harassment authorizations; request for comments.

SUMMARY: NMFS has received five requests for authorization to take marine mammals incidental to conducting geophysical survey activity in the Atlantic Ocean. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue incidental harassment authorizations (IHA) to incidentally take marine mammals during the specified activities.

DATES: Comments and information must be received no later than July 6, 2017.

ADDRESSES: Comments should be addressed to Jolie Harrison, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service. Physical comments should be sent to 1315 East-West Highway, Silver Spring, MD 20910 and electronic comments should be sent to *ITP.Laws@noaa.gov.*

Instructions: NMFS is not responsible for comments sent by any other method, to any other address or individual, or received after the end of the comment period. Comments received electronically, including all attachments, must not exceed a 25-megabyte file size. Attachments to electronic comments will be accepted in Microsoft Word or Excel or Adobe PDF file formats only. All comments received are a part of the public record and will generally be posted online at *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm* without change. All personal identifying information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit confidential business information or otherwise sensitive or protected information.

Information Solicited: NMFS is seeking public input on these requests for authorization as outlined below and request that interested persons submit information, suggestions, and comments concerning the applications. We will only consider comments that are relevant to marine mammal species that occur in U.S. waters of the Mid- and South Atlantic and the potential effects of geophysical survey activities on those species and their habitat.

Comments indicating general support for or opposition to hydrocarbon exploration or any comments relating to hydrocarbon development (*e.g.,* leasing, drilling) are not relevant to this request for comments and will not be considered. Comments should indicate whether they are general to the proposed authorizations described herein or are specific to one or more of the five proposed authorizations, and should be supported by data or literature citations as appropriate.

FOR FURTHER INFORMATION CONTACT: Ben Laws, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Availability

Electronic copies of the applications and supporting documents, as well as a list of the references cited in this document, may be obtained online at: *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.* In case of problems accessing these documents, please call the contact listed above.

National Environmental Policy Act

In 2014, the Bureau of Ocean Energy Management (BOEM) produced a Programmatic Environmental Impact Statement (PEIS) to evaluate potential significant environmental effects of geological and geophysical (G&G) activities on the Mid- and South Atlantic Outer Continental Shelf (OCS), pursuant to requirements of the National Environmental Policy Act (NEPA). These activities include geophysical surveys in support of hydrocarbon exploration, as are proposed in the MMPA applications before NMFS. The PEIS is available online at: *www.boem.gov/Atlantic-G-G-PEIS/.* NMFS participated in development of the PEIS as a cooperating agency and believes it appropriate to adopt the analysis in order to assess the impacts to the human environment of issuance of the subject IHAs. Information in the IHA applications, BOEM's PEIS, and this notice collectively provide the environmental information related to proposed issuance of these IHAs for public review and comment.

We will review all comments submitted in response to this notice as we complete the NEPA process, including a final decision of whether to adopt BOEM's PEIS and sign a Record of Decision related to issuance of IHAs, prior to a final decision on the incidental take authorization requests.

Background

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

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

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

Summary of Requests

In 2014–15, we received five separate requests for authorization for take of marine mammals incidental to geophysical surveys in support of hydrocarbon exploration in the Atlantic Ocean. The applicants are companies that provide services, such as geophysical data acquisition, to the oil and gas industry. Upon review of these requests, we submitted questions, comments, and requests for additional information to the individual applicant companies. As a result of these interactions, the applicant companies provided revised versions of the applications that we determined were adequate and complete.

On August 18, 2014, we received an application from Spectrum Geo Inc. (Spectrum), followed by revised versions on November 25, 2014, May 14, 2015, and July 6, 2015. TGS–NOPEC Geophysical Company (TGS) submitted an application on August 25, 2014, followed by revised versions on November 17, 2014, and July 21, 2015. We also received a request from ION GeoVentures (ION) on September 5, 2014, followed by a revised version on June 24, 2015.

We subsequently posted these applications for public review and sought public input (80 FR 45195; July 29, 2015), stating that we would only consider comments relevant to marine mammal species that occur in U.S. waters of the Mid- and South Atlantic and the potential effects of geophysical survey activities on those species. We stated further that any comments should be supported by data or literature citations as appropriate, that comments indicating general support for or opposition to oil and gas exploration and development would not be considered inasmuch as such comments are not relevant to our consideration of the requests under the MMPA, and that we were particularly interested in information addressing the following topics:

1. Best available scientific information and appropriate use of such information in assessing potential effects of the specified activities on marine mammals and their habitat;
2. Application approaches to estimating acoustic exposure and take of marine mammals; and,
3. Appropriate mitigation measures and monitoring requirements for these activities.

We note that this notice for proposed IHAs does not concern one additional company (TDI-Brooks International, Inc. (TDI Brooks)) whose application was referenced in our July 29, 2015, **Federal Register** notice, and includes two other companies (WesternGeco, LLC (Western) and CGG) whose applications were not included in our July 29, 2015, notice. TDI-Brooks International, Inc. submitted a request for authorization related to a proposed survey to conduct deep water multibeam bathymetry and sub-bottom profiler data acquisition on October 22, 2014. However, public comment indicated that this application was improperly considered adequate and complete, and we subsequently concurred with this assessment and returned the application to TDI-Brooks for revision. We will provide separate notice of any proposed authorization related to this applicant upon receipt of an adequate and complete application, if appropriate.

The comments and information received during this public review period informed development of the proposed IHAs discussed in this notice, and all letters received are available online at *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.*

Following the close of the public review period, we received revised versions of several applications: From Spectrum on September 18, 2015, and from TGS on February 10, 2016. We received additional information from ION on February 29, 2016. Spectrum revised the scope of their proposed survey effort, while TGS and ION revised their estimates of the number of potential incidents of marine mammal exposure to underwater noise. Western submitted a request for authorization on March 3, 2015, followed by a revised version on February 17, 2016, that we determined was adequate and complete. CGG submitted a request for authorization on December 21, 2015, followed by revised versions on February 18, 2016, April 6, 2016, and May 26, 2016. These applications are adequate and complete at this time and are substantially similar to other applications previously released for public review. We do not anticipate offering additional discretionary public review of applications should we receive further requests for authorization related to proposed geophysical survey activity in the Atlantic Ocean.

All requested authorizations would be valid for the statutory maximum of one year from the date of effectiveness. All applicants propose to conduct two-dimensional (2D) marine seismic surveys using airgun arrays. Generally speaking, these surveys may occur within the U.S. Exclusive Economic Zone (*i.e.,* to 200 nautical miles (nmi)) from Delaware to approximately Cape Canaveral, Florida and corresponding with BOEM's Mid- and South Atlantic OCS planning areas, as well as additional waters out to 350 nmi from shore (Figure 1). Please see the applications for specific details of survey design. The use of airgun arrays is expected to produce underwater sound at levels that have the potential to result in harassment of marine mammals. Multiple cetacean species with the expected potential to be present during all or a portion of the proposed surveys are described below.

Because the specified activity, specified geographic region, and proposed dates of activity are substantially similar for the five separate requests for authorization, we have determined it appropriate to provide a joint notice for the five proposed authorizations. However, while we provide relevant information together, we consider the potential impacts of the specified activities independently and make preliminary determinations specific to each request for authorization, as required by the MMPA.

Description of the Specified Activities

In this section, we provide a generalized discussion that is broadly applicable to all five requests for authorization, with project-specific portions indicated.

Overview

The five applicants propose to conduct deep penetration seismic surveys using airgun arrays as an acoustic source. Seismic surveys are one method of obtaining geophysical data used to characterize the subsurface structure, in this case in support of hydrocarbon exploration. The proposed surveys would be 2D surveys, designed to acquire data over large areas in order to screen for potential hydrocarbon prospectivity. To contrast, three-dimensional surveys may use similar acoustic sources but are designed to cover smaller areas with greater resolution (*e.g.,* with closer survey line spacing). A deep penetration survey uses an acoustic source suited to provide data on geological formations that may be thousands of meters (m) beneath the seafloor, as compared with a survey that may be intended to evaluate shallow subsurface formations or the seafloor itself (*e.g.,* for hazards).

An airgun is a device used to emit acoustic energy pulses into the seafloor, and generally consists of a steel cylinder that is charged with high-pressure air. Release of the compressed air into the water column generates a signal that reflects (or refracts) off of the seafloor and/or subsurface layers having acoustic impedance contrast. When fired, a brief (~0.1 second (s)) pulse of sound is emitted by all airguns nearly simultaneously. The airguns are silent during the intervening periods, with the array typically fired on a fixed distance (or shot point) interval. This interval may vary depending on survey objectives, but a typical interval for a 2D survey in relatively deep water might be 25 m (approximately every 10 s, depending on vessel speed). The return signal is recorded by a listening device and later analyzed with computer interpretation and mapping systems used to depict the subsurface. In this case, towed streamers contain hydrophones that would record the return signal.

Individual airguns are available in different volumetric sizes and, for deep penetration seismic surveys, are towed in arrays (*i.e.,* a certain number of airguns of varying sizes in a certain arrangement) designed according to a given company's method of data acquisition, seismic target, and data processing capabilities. A typical large airgun array, as was considered in BOEM's PEIS (BOEM, 2014a), may have a total volume of approximately 5,400 in^3. The notional array modeled by BOEM consists of 18 airguns in three identical strings of six airguns each, with individual airguns ranging in volume from 105–660 in^3. Sound levels for airgun arrays are typically modeled or measured at some distance from the source and a nominal source level then back-calculated. Because these arrays constitute a distributed acoustic source rather than a single point source (*i.e.,* the ''source'' is actually comprised of multiple sources with some pre-determined spatial arrangement), the highest sound levels measurable at any location in the water will be less than the nominal source level. A common analogy is to an array of light bulbs; at sufficient distance the array will appear to be a single point source of light but individual sources, each with less intensity than that of the whole, may be discerned at closer distances. In addition, the effective source level for sound propagating in near-horizontal directions (*i.e.,* directions likely to impact most marine mammals in the vicinity of an array) is likely to be substantially lower than the nominal source level applicable to downward propagation because of the directional nature of the sound from the airgun array. The horizontal propagation of sound is reduced by noise cancellation effects created when sound from neighboring airguns on the same horizontal plane partially cancel each other out.

Survey protocols generally involve a predetermined set of survey, or track, lines. The seismic acquisition vessel (source vessel) will travel down a linear track for some distance until a line of data is acquired, then turn and acquire data on a different track. In addition to the line over which data acquisition is desired, full-power operation may include run-in and run-out. Run-in is approximately 1 kilometer (km) of full-power source operation before starting a new line to ensure equipment is functioning properly, and run-out is additional full-power operation beyond the conclusion of a trackline (typically half the distance of the acquisition streamer behind the source vessel) to ensure that all data along the trackline are collected by the streamer. Line turns typically require two to three hours due to the long trailing streamers (*e.g.,* 10 km). Spacing and length of tracks varies by survey. Survey operations often involve the source vessel, supported by a chase vessel. Chase vessels typically support the source vessel by protecting the long hydrophone streamer from damage (*e.g.,* from other vessels) and otherwise lending logistical support (*e.g.,* returning to port for fuel, supplies, or any necessary personnel transfers). Chase vessels do not deploy acoustic sources for data acquisition purposes; the only potential effects of the chase vessels are those associated with normal vessel operations.

Dates and Duration

All companies requested IHAs covering the statutory maximum of one year from the date of issuance, but the expected temporal extent of survey activity varies by company and may be subject to unpredictability due to inclement weather days, equipment maintenance and/or repair, transit to and from ports to survey locations, and other contingencies. Spectrum plans a six-month data acquisition program, consisting of an expected 165 days of seismic operations. TGS plans a full year data acquisition program, with an estimated 308 days of seismic operations. ION plans a six-month data acquisition program, with an estimated 70 days of seismic data collection. Western plans a full year data acquisition program, with an estimated 208 days of seismic operations. CGG plans a six-month data acquisition program (July–December), with an estimated 155 days of seismic operations. Seismic operations would typically occur 24 hours per day.

Specific Geographic Region

The proposed survey activities would occur off the Atlantic coast of the U.S., within BOEM's Mid-Atlantic and South Atlantic OCS planning areas (*i.e.,* from Delaware to Cape Canaveral, FL), and out to 350 nmi (648 km) (see Figure 1, reproduced from BOEM, 2014a). The seaward limit of the region is based on the maximum constraint line for the extended continental shelf (ECS) under the United Nations Convention on the Law of the Sea. Until such time as an ECS is established by the U.S., the region between the U.S. exclusive economic zone (EEZ) boundary and the ECS maximum constraint line (*i.e.,* 200–350 nmi from shore) is part of the global commons, and BOEM determined it appropriate to include this area within the area of interest for geophysical survey activity.

The specific survey areas differ within this region; please see maps provided in the individual applications (Spectrum: Figure 1; Western: Figures 1–1 to 1–4; TGS: Figures 1–1 to 1–4; ION: Figure 1; CGG: Figure 3). A map of all proposed surveys may be viewed online at: *www.boem.gov/Atlantic-G-and-G-Permitting/* (accessed on October 18, 2016); however, note that this map displays all permits requested from BOEM, including potential surveys for companies who have not yet requested authorization under the MMPA. The survey shown as ''GXTechnology'' on the referenced map is the same as what we describe here as being proposed by ION. In addition to general knowledge and other citations contained herein, this section relies upon the descriptions found in Sherman and Hempel (2009) and Wilkinson *et al.* (2009). As referred to here, productivity refers to fixated carbon (*i.e.,* g $C/m^2/yr$) which relates to the carrying capacity of an ecosystem.

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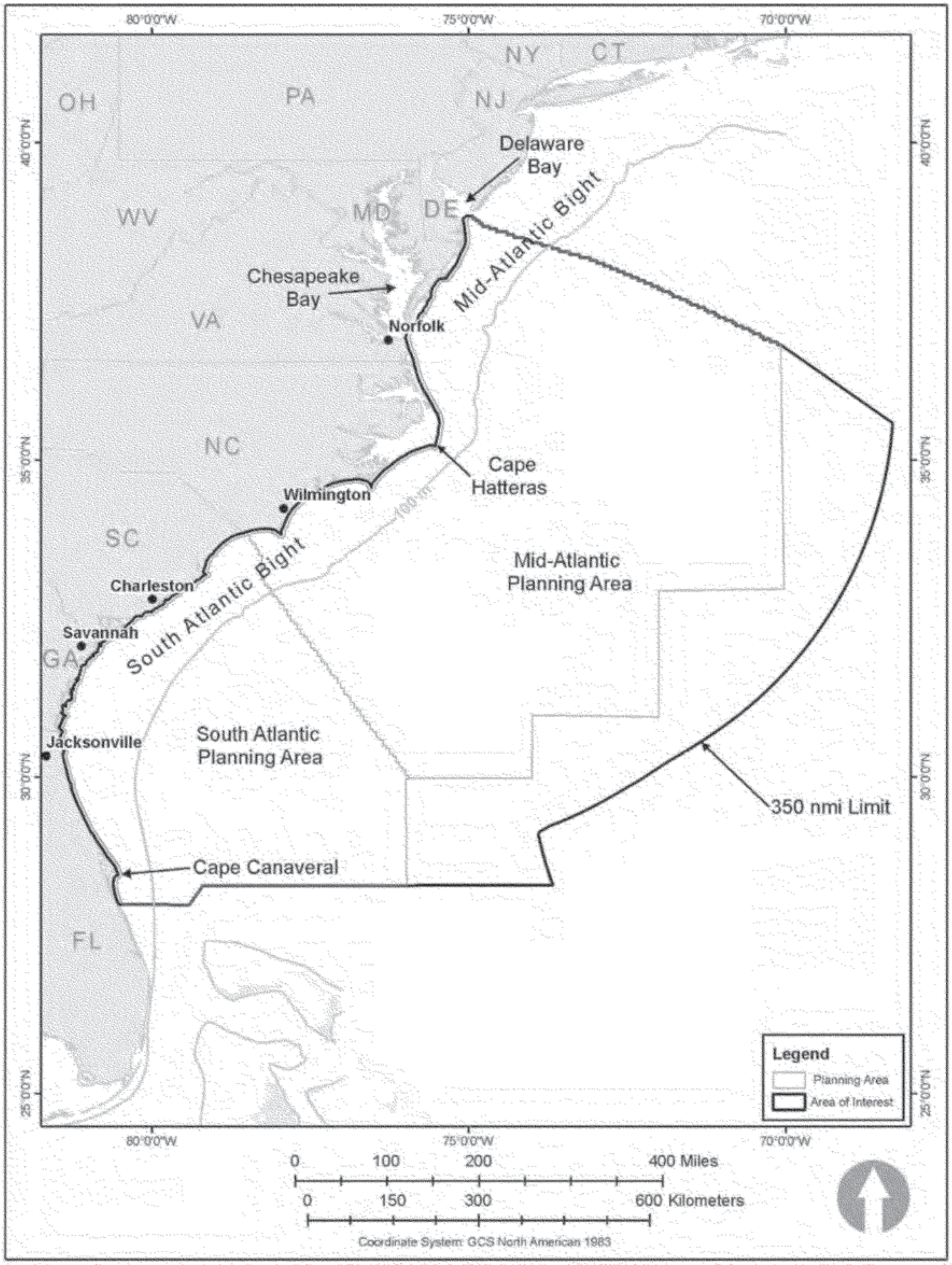

Figure 1. Specific Geographic Region

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The entire U.S. Atlantic coast region extends from the Gulf of Maine past Cape Hatteras to Florida. The region is characterized by its temperate climate and proximity to the Gulf Stream Current, and is generally considered to be of moderately high productivity, although the portion of the region from Cape Cod to Cape Hatteras is one of the most productive areas in the world due to upwellings along the shelf break created by the western edge of the Gulf Stream. Sea surface temperatures (SST) exhibit a broad range across this region, with winter temperatures ranging from 2–20 °C in the north and 15–22 °C in the south, while summer temperatures, consistent in the south at approximately 28 °C, range from 15–27 °C in the northern portion.

The northern portion of this region (*i.e.,* north of Cape Hatteras) is more complex, with four major sub-areas, only one of which is within the specified geographic region: The Mid-Atlantic Bight (MAB). South of Cape Cod, there is strong stratification along the coast where large estuaries occur (*e.g.,* Chesapeake Bay, Pamlico Sound). The Gulf Stream is highly influential on both the northern and southern portions of the region, but in different ways. Meanders of the current directly affect the southern portion of the region, where the Gulf Stream is closer to shore, while warm-core rings indirectly affect the northern portion (Belkin *et al.,* 2009). In addition, subarctic influences can reach as far south as the MAB, but the convergence of the Gulf Stream with the coast near Cape Hatteras does not allow for significant northern influence into waters of the South Atlantic Bight.

The MAB includes the continental shelf and slope waters from Georges Bank to Cape Hatteras, NC. The retreat of the last ice sheet shaped the morphology and sediments of this area. The continental shelf south of New England is broad and flat, dominated by fine grained sediments (sand and silt). The shelf slopes gently away from the shore out to approximately 100 to 200 km offshore, where it transforms into the continental slope at the shelf break (at water depths of 100 to 200 m). Along the shelf break, numerous deep-water canyons incise the slope and shelf. The sediments and topography of the canyons are much more heterogeneous than the predominantly sandy top of the shelf, with steep walls and outcroppings of bedrock and deposits of clay.

The southwestern flow of cold shelf water feeding out of the Gulf of Maine and off Georges Bank dominates the circulatory patterns in this area. The countervailing Gulf Stream provides a source of warmer water along the coast as warm-core rings and meanders break off from the Gulf Stream and move shoreward, mixing with the colder shelf and slope water. As the shelf plain narrows to the south (the extent of the continental shelf is narrowest at Cape Hatteras), the warmer Gulf Stream waters run closer to shore.

The southeast continental shelf area extends approximately 1,500 km from Cape Hatteras, NC south to the Straits of Florida (Yoder, 1991). The continental shelf in the region reaches up to approximately 200 km offshore. The Gulf Stream influences the region with minor upwelling occurring along the Gulf Stream front. The area is approximately 300,000 km^2, includes several protected areas and coral reefs (Aquarone, 2008); numerous estuaries and bays, nearshore and barrier islands; and extensive coastal marshes that provide habitats for numerous marine and estuarine species. A 10–20 km wide coastal zone is characterized by high levels of primary production throughout the year, while offshore, on the middle and outer shelf, upwelling along the Gulf Stream front and intrusions from the Gulf Stream cause seasonal phytoplankton blooms. Because of its high productivity, this sub-region supports active commercial and recreational fisheries (Shertzer *et al.,* 2009).

Detailed Description of Activities

Detailed survey descriptions, as given in specific applications, are provided here without regard for the mitigation measures proposed by NMFS. In some cases, our proposed mitigation measures may affect the proposed survey plan (*e.g.,* distance from coast, areas to be avoided at certain times of year). Please see ''Proposed Mitigation,'' later in this document, for details on those proposed mitigation requirements. Please see Table 1 for a summary of airgun array characteristics.

ION—ION proposes to conduct a 2D marine seismic survey off the U.S. east coast from Delaware to northern Florida (~38.5° N. to ~27.9° N.), and from 20 km from the coast to >600 km from the coast (see Figure 1 of ION's application). The survey would involve one source vessel, the M/V *Discoverer,* and one chase vessel, the M/V *Octopus,* or similar (see ION's application for vessel details). The *Discoverer* has a cruising speed of 9.5 knots (kn), maximum speed of 10 kn, and would tow gear during data acquisition at ~4 kn. The survey plan consists of five widely-spaced transect lines (~20–190 km apart) roughly parallel to the coast and 14 widely-spaced transect lines (~30–220 km apart) in the onshore-offshore direction totaling ~13,062 km of data acquisition line. Effort planned by depth bin is as follows: ~48 percent >3,000 m; ~18 percent 1,000–3,000 m; ~22 percent 100–1,000 m; ~12 percent <100 m. There would be limited additional operations associated with equipment testing, startup, line changes, and repeat coverage of any areas where initial data quality is sub-standard. Therefore, there could be some small amount of use of the acoustic source not accounted for in the total estimated line-km; however, this activity is difficult to quantify in advance and would represent an insignificant increase in effort.

The acoustic source planned for deployment is a 36-airgun array with a total volume of 6,420 in^3. The source vessel would tow a single hydrophone streamer, up to 12 km long. The 36-airgun array would consist of a mixture of Bolt 1500LL and sleeve airguns ranging in volume from 40 in^3 to 380 in^3; the larger (300–380 in^3) airguns would be Bolt airguns, and the smaller (40–150 in^3) airguns would be sleeve airguns. The difference between the two types of airguns is in the mechanical parts that release the pressurized air; however, the bubble and acoustic energy released by the two types of airguns are effectively the same. The airguns would be configured as four identical linear arrays or ''strings'' (see Figure 3 of ION's application). Each string would have nine airguns; the first and last airguns in the strings would be spaced ~15.5 m apart.

The four airgun strings would be distributed across an approximate area of 34 x 15.5 m behind the vessel and would be towed ~50–100 m behind the vessel at 10-m depth. The firing pressure of the array would be 2,000 pounds per square inch (psi). The airgun array would fire every 50 m or 20–24 s, depending on exact vessel speed—a longer interval than is typical of most industry seismic surveys. ION provided modeling results for their array, including notional source signatures, 1/3-octave band source levels as a function of azimuth angle, and received sound levels as a function of distance and direction at 16 representative sites in the proposed survey area. For more detail, please see ''Estimated Take by Incidental Harassment,'' later in this document, as well as Figures 4–6 and Appendix A of ION's application.

Spectrum—Spectrum proposes to conduct a 2D marine seismic survey off the U.S. east coast from Delaware to northern Florida, extending throughout BOEM's Mid- and South Atlantic OCS planning areas. The survey would be conducted on an approximately 25 x 32 km grid; grid size may vary to minimize overall survey distance (see Figure 1 of Spectrum's application). The closest trackline to shore would be approximately 35 km (off Cape Hatteras). The survey would involve one source vessel and one chase vessel (see Spectrum's application for vessel details). The survey plan includes a total of approximately 21,635 km of data acquisition line, including allowance for lines expected to be resurveyed due to environmental or technical reasons. Water depths range from 30 to 5,410 m. There would be limited additional operations associated with equipment testing, startup, and repeat coverage of any areas where initial data quality is sub-standard.

The acoustic source planned for deployment is a 32-airgun array with a total volume of 4,920 in^3. The source vessel would tow a single 12-km hydrophone streamer. The 32-airgun array would consist of individual airguns ranging in volume from 50 in^3 to 250 in^3. The firing pressure of the array would be 2,000 psi. The airguns would be configured as four subarrays (see Figure 2 in Appendix A of Spectrum's application). Each string would have eight to ten airguns and strings would be spaced 10 m apart; the total array dimensions would be 40 m wide x 30 m long.

The four airgun strings would be towed at 6 to 10-m depth and the airgun array would fire every 25 m or 10 s, depending on exact vessel speed (expected to be 4–5 kn). Spectrum provided modeling results for their array, including notional source signatures, 1/3-octave band source levels as a function of azimuth angle, and received sound levels as a function of distance and direction at 16 representative sites in the proposed survey area. For more detail, please see Appendix A of Spectrum's application, as well as ''Estimated Take by Incidental Harassment,'' later in this document.

TGS—TGS proposes to conduct a 2D marine seismic survey off the U.S. east coast from Delaware to northern Florida, extending throughout BOEM's Mid- and South Atlantic OCS planning areas (see Figure 1–1 of TGS's application). The survey would involve two source vessels operating independently of one another (expected to operate at least 100 km apart), with each attended by one chase vessel. This approach was selected to allow TGS to complete the survey plan within one year rather than spread over multiple years. The survey plan consists of two contiguous survey grids with differently spaced lines (see Figures 1–1 to 1–4 of TGS's application). Lines are spaced 100 km apart in approximately the eastern half of the project area and approximately 25 km apart in the western portion of the survey area. A third, more detailed grid (6–10 km spacing) covers the continental shelf drop-off, approximately near the center of the proposed survey area from north to south. The closest trackline to the coast would be 25 km. The survey plan includes a total of 55,133 km of data acquisition line plus an additional 3,167 km of trackline expected for run-in/run-out, for a total of 58,300 km. Water depths range from 25–5,500 m. There would be limited additional operations associated with equipment testing, startup, line changes, and repeat coverage of any areas where initial data quality is sub-standard.

The acoustic sources planned for deployment are 48-airgun arrays with a total volume of 4,808 in^3. However, only 40 individual airguns would be used at any given time, with remaining airguns held in reserve in case of equipment failure. The source vessels would tow a single 12-km long hydrophone streamer. The airgun array would use Sodera G-gun II airguns ranging in volume from 22 in^3 to 250 in^3. The airguns would be configured as four identical subarrays (see Figure 3 in Appendix B of TGS's application), with individual elements spaced 8 m apart and arranged such that the largest elements are in the middle of each subarray and smaller sources at the front and end. The four airgun strings would be towed behind the vessel at 7-m depth. The airgun array would fire every 25 m (approximately every 10 s, depending on vessel speed), with expected transit speed of 4–5 kn. More detail regarding TGS's acoustic source and modeling related to TGS's application is provided in ''Estimated Take by Incidental Harassment,'' later in this document, as well as Appendix B of TGS's application.

Western—Western proposes to conduct a 2D marine seismic survey off the U.S. east coast from Maryland to northern Florida, extending through the majority of BOEM's Mid- and South Atlantic OCS planning areas (see Figure 1–1 of Western's application). The survey plan consists of a survey grid with differently spaced lines (see Figures 1–1 to 1–4 of Western's application). Lines are spaced 25 km apart in approximately the southwestern third of the project area and approximately 6 km apart in the remainder of the survey area. The closest trackline to the coast would be 30 km. The survey plan includes a total of 26,641 km of data acquisition line plus an additional 689 km of lines expected for run-in/run-out, for a total of 27,330 km. Water depths range from 20–4,700 m. The survey would involve one source vessel, the M/V *Western Pride,* as well as two chase vessels, the M/V *Michael Lawrence* and M/V *Amber G,* and a supply vessel, the M/V *Melinda B. Adams* or similar (see Appendix B of Western's application for vessel details). There would be limited additional operations associated with equipment testing, startup, and repeat coverage of any areas where initial data quality is sub-standard.

The seismic source planned for deployment is a 24-airgun array with a total volume of 5,085 in^3. The source vessel would tow a single 10.5-km hydrophone streamer. The 24-airgun array would consist of individual Bolt v5085 airguns. The airguns would be configured as three identical subarrays of eight airguns each with 8 m spacing between strings. The three airgun strings would be towed at 10-m depth and the airgun array would fire every 37.5 m (approximately every 16 s, depending on vessel speed), with expected transit speed of 4–5 kn. More detail regarding Western's acoustic source and modeling related to Western's application is provided in ''Estimated Take by Incidental Harassment,'' later in this document, as well as Appendix B of Western's application.

CGG—CGG proposes to conduct a 2D marine seismic survey off the U.S. east coast from Virginia to Georgia, extending through the majority of BOEM's Mid- and South Atlantic OCS planning areas (see Figure 3 of CGG's application). The survey plan consists of 53 survey tracklines in a 20 km by 20 km orthogonal grid (see Figure 3 of CGG's application). The tracklines would be 300 to 750 km in length, with the closest trackline to the coast at 80 km. The survey plan includes a total of 28,670 km of data acquisition line, in water depths ranging from 100–5,000 m. The survey would involve one source vessel, as well as two support vessels. There would be limited additional operations associated with equipment testing, startup, and repeat coverage of any areas where initial data quality is sub-standard.

The seismic source planned for deployment is a 36-airgun array with a total volume of 5,400 $in.^3$ The source vessel would tow a single 10 to 12-km hydrophone streamer. The 36-airgun array would consist of individual Bolt 1900/1500 airguns. The airguns would be configured as four subarrays of nine airguns each (see Figure 2 in CGG's application), with total dimensions of 24 m width by 16.5 m length and 8 m separation between strings. The four airgun strings would be towed at 7-m depth and the airgun array would fire every 25 m (approximately every 16 s, depending on vessel speed), with expected transit speed of 4.5 kn. More detail regarding CGG's acoustic source and modeling related to CGG's application is provided in ''Estimated Take by Incidental Harassment,'' later in this document, as well as CGG's application.

TABLE 1—SURVEY AND AIRGUN ARRAY CHARACTERISTICS

Company	Total planned survey (km)	Total volume (in³)	Number of guns	Number of strings	Nominal source output (downward) [1]			Shot interval (m)	Tow depth (m)
					0-pk	pk-pk	rms		
ION	13,062	6,420	36	4	257	263	[4] 247	50	10
Spectrum	21,635	4,920	32	4	266	272	243	25	6–10
TGS	58,300	4,808	40	4	255	[3]	240	25	7
Western	27,330	5,085	24	3	[3]	262	235	37.5	10
CGG	28,670	5,400	36	4	[3]	259	[3 4] 243	25	7
BOEM [2]	n/a	5,400	18	3	247	[3]	233	n/a	6.5

[1] See "Description of Active Acoustic Sound Sources," later in this document, for discussion of these concepts.
[2] Notional array characteristics modeled and source characterization outputs from BOEM's PEIS (2014a) provided for comparison.
[3] Values not given; however, SPL (pk-pk) is usually considered to be approximately 6 dB higher than SPL (0-pk) (Greene, 1997).
[4] Value decreased from modeled 0-pk value by minimum 10 dB (Greene, 1997).

Proposed Mitigation

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, "and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking" for certain subsistence uses. NMFS regulations require applicants for incidental take authorizations to include information about the availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks and their habitat (50 CFR 216.104(a)(11)). Here we provide a single description of proposed mitigation measures, including those contained in the applicants' requests, as we propose to require the same measures of all applicants.

We reviewed the applicants' proposals, the requirements specified in BOEM's PEIS, seismic mitigation protocols required or recommended elsewhere (*e.g.,* DOC, 2013; IBAMA, 2005; Kyhn *et al.,* 2011; JNCC, 2010; DEWHA, 2008; BOEM, 2016a; DFO, 2008; MMOA, 2015; Nowacek and Southall, 2016), and the available scientific literature. We also considered recommendations given in a number of review articles (*e.g.,* Weir and Dolman, 2007; Compton *et al.,* 2008; Parsons *et al.,* 2009; Wright and Cosentino, 2015; Stone, 2015). The suite of mitigation measures proposed here differs in some cases from the measures proposed by the applicants and/or those specified by BOEM in their PEIS and Record of Decision (ROD) in order to reflect what we believe to be the most appropriate suite of measures to satisfy the requirements of the MMPA. In carrying out the MMPA's mandate, we apply a context-specific balance between the manner in which and the degree to which measures are expected to reduce impacts to the affected species or stocks and their habitat and practicability for the applicant. (The framework for such an evaluation is explained further in 82 FR 19460, 19502 (April 27, 2017) (Proposed Rule for Take of Marine Mammals Incidental to U.S. Navy Operation of Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar.) Both of these facets point to the need for a basic system of seismic mitigation protocols (which may be augmented as necessary) that may be implemented in the field, reduce subjective decision-making for observers to the extent possible, and appropriately weighs a range of potential outcomes from sound exposure in determining what should be avoided or minimized where possible.

Past mitigation protocols for geophysical survey activities using airgun arrays have focused on avoidance of exposures to received sound levels exceeding NMFS's historical injury criteria (*e.g.,* 180 dB rms), rather than also weighing the potentially detrimental effects of increased input of sound at lower levels into the environment (*e.g.,* through use of mitigation guns or extended periods on the water to reshoot lines following shutdowns of the acoustic source), while also unrealistically assuming that shutdown protocols are capable of avoiding all potential for auditory injury. In addition to a basic suite of seismic mitigation protocols, we also include measures that might not be required for other activities (*e.g.,* time-area closures specific to the proposed surveys discussed here) but that are warranted here given the proposed spatiotemporal scope of these specified activities and associated potential for population-level effects and/or take of large numbers of individuals of certain species.

Mitigation-Related Monitoring

Monitoring by independent, dedicated, trained marine mammal observers is required. Note that, although we propose requirements related only to observation of marine mammals, we hereafter use the generic term "protected species observer" (PSO) to avoid confusion with protocols that may be required of the applicants pursuant to other relevant statutes. Independent observers are employed by a third-party observer provider; vessel crew may not serve as PSOs. Dedicated observers are those who have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct the seismic survey operator (*i.e.,* vessel captain and crew) with regard to the presence of marine mammals and mitigation requirements. Communication with the operator may include brief alerts regarding maritime hazards. Trained PSOs have successfully completed an approved PSO training course (see "Proposed Monitoring and Reporting"), and experienced PSOs have additionally gained a minimum of 90 days at-sea experience working as a PSO during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. Both visual and acoustic monitoring is required; training and experience is specific to either visual or acoustic PSO duties. An experienced visual PSO must have completed approved, relevant training and gained the requisite experience working as a visual PSO. An experienced acoustic PSO must have completed a passive acoustic monitoring (PAM) operator training course and gained the requisite experience working as an acoustic PSO (*i.e.,* PAM operator).

NMFS does not currently approve specific training courses; observers may be considered appropriately trained by having satisfactorily completed training that meets all the requirements specified herein (see ''Proposed Monitoring and Reporting''). In order for PSOs to be approved, NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course. A PSO may be trained and/or experienced as both a visual PSO and PAM operator and may perform either duty, pursuant to scheduling requirements. PSO watch schedules shall be devised in consideration of the following restrictions: (1) A maximum of two consecutive hours on watch followed by a break of at least one hour between watches for visual PSOs; (2) a maximum of four consecutive hours on watch followed by a break of at least two consecutive hours between watches for PAM operators; and (3) a maximum of 12 hours observation per 24-hour period. Further information regarding PSO requirements may be found in the ''Proposed Monitoring and Reporting'' section, later in this document.

Visual—All source vessels must carry a minimum of one experienced visual PSO, who shall be designated as the lead PSO, coordinate duty schedules and roles, and serve as primary point of contact for the operator. While it is desirable for all PSOs to be qualified through experience, we do not wish to foreclose opportunity for newly trained PSOs to gain the requisite experience. Therefore, the lead PSO shall devise the duty schedule such that experienced PSOs are on duty with trained PSOs (*i.e.,* those PSOs with appropriate training but who have not yet gained relevant experience) to the maximum extent practicable in order to provide necessary mentorship. During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array (see ''Ramp-ups'' below). PSOs should use NOAA's solar calculator (*www.esrl.noaa.gov/gmd/grad/solcalc/*) to determine sunrise and sunset times at their specific location. We recognize that certain daytime conditions (*e.g.,* fog, heavy rain) may reduce or eliminate effectiveness of visual observations; however, on-duty PSOs shall remain alert for marine mammal observational cues and/or a change in conditions.

With regard to specific observational protocols, we largely follow those described in Appendix C of BOEM's PEIS (BOEM, 2014a). The lead PSO shall determine the most appropriate observation posts that will not interfere with navigation or operation of the vessel while affording an optimal, elevated view of the sea surface. PSOs shall coordinate to ensure 360° visual coverage around the vessel, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner. Within these broad outlines, the lead PSO and PSO team will have discretion to determine the most appropriate vessel- and survey-specific system for implementing effective marine mammal observational effort. Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, should be relayed to the source vessel and to the PSO team.

Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset. If any marine mammal is observed at any distance from the vessel, a PSO would record the observation and monitor the animal's 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. A PSO would continue to observe the area to watch for the animal to resurface or for additional animals that may surface in the area. Visual PSOs shall communicate all observations to PAM operators, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), PSOs should conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods.

Acoustic—All source vessels must use a towed PAM system for potential detection of marine mammals. The system must be monitored at all times during use of the acoustic source, and acoustic monitoring must begin at least 30 minutes prior to ramp-up. All source vessels shall carry a minimum of one experienced PAM operator. PAM operators shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination. We acknowledge generally that PAM has significant limitations. For example, animals may only be detected when vocalizing, species making directional vocalizations must vocalize towards the array to be detected, species identification and localization may be difficult, etc. However, we believe that for certain species and in appropriate environmental conditions it is a useful complement to visual monitoring during good sighting conditions and that it is the only meaningful monitoring technique during periods of poor visibility. Further detail regarding PAM system requirements may be found in the ''Proposed Monitoring'' section, later in this document. The effectiveness of PAM depends to a certain extent on the equipment and methods used and competency of the PAM operator, but no established standards are currently in place. We do offer some specifications later in this document and each applicant has provided a PAM plan.

Following protocols described by the New Zealand Department of Conservation for seismic surveys conducted in New Zealand waters (DOC, 2013), survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

- Daylight hours and sea state is less than or equal to Beaufort sea state (BSS) 4;
- No marine mammals (excluding small delphinoids; see below) detected solely by PAM in the exclusion zone (see below) in the previous two hours;
- NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and
- Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

As noted previously, all source vessels must carry a minimum of one experienced visual PSO and one experienced PAM operator. Although a given PSO may carry out either visual PSO or PAM operator duties during a survey (assuming appropriate training), the required experienced PSOs may not be the same person. The observer designated as lead PSO (including the full team of visual PSOs and PAM operators) must be an experienced visual PSO. The applicant may determine how many PSOs are required to adequately fulfill the requirements specified here. To summarize, these requirements are: (1) Separate experienced visual PSOs and PAM operators; (2) 24-hour acoustic monitoring during use of the acoustic source; (3) visual monitoring during use of the acoustic source by two PSOs during all daylight hours and during nighttime ramp-ups; (4) maximum of two consecutive hours on watch followed by a minimum of one hour off watch for visual PSOs and a maximum of four consecutive hours on watch followed by a minimum of two consecutive hours off watch for PAM operators; and (5) maximum of 12 hours of observational effort per 24-hour period for any PSO, regardless of duties.

Buffer Zone and Exclusion Zone

The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown of the acoustic source. Use of the buffer zone in relation to ramp-up is discussed under ''Ramp-up.'' Further detail regarding the exclusion zone and shutdown requirements is given under ''Exclusion Zone and Shutdown Requirements.''

Ramp-Up

Ramp-up of an acoustic source is intended to provide a gradual increase in sound levels, enabling animals to move away from the source if the signal is sufficiently aversive prior to its reaching full intensity. We infer on the basis of behavioral avoidance studies and observations that this measure results in some reduced potential for auditory injury and/or more severe behavioral reactions. Dunlop *et al.* (2016) studied the effect of ramp-up during a seismic airgun survey on migrating humpback whales, finding that although behavioral response indicating potential avoidance was observed, there was no evidence that ramp-up was more effective at causing aversion than was a constant source. Regardless, the majority of whale groups did avoid the source vessel at distances greater than the radius of most mitigation zones (Dunlop *et al.,* 2016). Although this measure is not proven and some arguments have been made that use of ramp-up may not have the desired effect of aversion (which is itself a potentially negative impact assumed to be better than the alternative), ramp-up remains a relatively low cost, common sense component of standard mitigation. Ramp-up is most likely to be effective for more sensitive species (*e.g.,* beaked whales) with known behavioral responses at greater distances from an acoustic source (*e.g.,* Tyack *et al.,* 2011; DeRuiter *et al.,* 2013; Miller *et al.,* 2015).

The ramp-up procedure involves a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved. Ramp-up is required at all times as part of the activation of the acoustic source (including source tests; see ''Miscellaneous Protocols'' for more detail) and may occur at times of poor visibility, assuming appropriate acoustic monitoring with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation should only occur at night where operational planning cannot reasonably avoid such circumstances. For example, a nighttime initial ramp-up following port departure is reasonably avoidable and may not occur. Ramp-up may occur at night following acoustic source deactivation due to line turn or mechanical difficulty. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.

Ramp-up procedures follow the recommendations of IAGC (2015). Ramp-up would begin by activating a single airgun (*i.e.,* array element) of the smallest volume in the array. Ramp-up continues in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. There will generally be one stage in which doubling the number of elements is not possible because the total number is not even. This should be the last stage of the ramp-up sequence. These requirements may be modified on the basis of any new information presented that justifies a different protocol. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups should be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in. We adopt this approach to ramp-up (increments of array elements) because it is relatively simple to implement for the operator as compared with more complex schemes involving activation by increments of array volume, or activation on the basis of element location or size. Such approaches may also be more likely to result in irregular leaps in sound output due to variations in size between individual elements within an array and their geometric interaction as more elements are recruited. It may be argued whether smooth incremental increase is necessary, but stronger aversion than is necessary should be avoided. The approach proposed here is intended to ensure a perceptible increase in sound output per increment while employing increments that produce similar degrees of increase at each step.

PSOs must monitor a 1,000-m buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance). The pre-clearance period may occur during any vessel activity (*i.e.,* transit, line turn). Ramp-up should be planned to occur during periods of good visibility when possible; operators should not target the period just after visual PSOs have gone off duty. Following deactivation of the source for reasons other than mitigation, the operator must communicate the near-term operational plan to the lead PSO with justification for any planned nighttime ramp-up. Any suspected patterns of abuse should be reported by the lead PSO and would be investigated by NMFS. Ramp-up may not be initiated if any marine mammal (including small delphinoids) is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs will monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone.

Exclusion Zone and Shutdown Requirements

An exclusion zone is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce potential for certain outcomes, *e.g.,* auditory injury, disruption of critical behaviors. The PSOs must establish a minimum exclusion zone with a 500 m radius as a perimeter around the airgun array (rather than being centered on the array or around the vessel itself). If a marine mammal appears within, enters, or appears on a course to enter this zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the PAM operator is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement (see below).

This shutdown requirement is in place for all marine mammals, with the exception of small delphinoids under certain circumstances. As defined here, the small delphinoid group is intended to encompass those members of the Family Delphinidae most likely to voluntarily approach the source vessel for purposes of interacting with the vessel and/or airgun array (*e.g.,* bow riding). This exception to the shutdown requirement applies solely to specific genera of small dolphins—*Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus* (see Table 4)—and only applies if the animals are traveling, including approaching the vessel. If, for example, an animal or group of animals is stationary for some reason (*e.g.,* feeding) and the source vessel approaches the animals, the shutdown requirement applies. An animal with sufficient incentive to remain in an area rather than avoid an otherwise aversive stimulus could either incur auditory injury or disruption of important behavior. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented. We do not require that a PSO determine the intent of the animal(s)—an inherently subjective proposition—but simply whether any potential intersection of the animal with the 500-m exclusion zone would be caused due to the vessel's approach towards relatively stationary animals.

We propose this small delphinoid exception because a shutdown requirement for small delphinoids under all circumstances is of known concern regarding practicability for the applicant due to increased shutdowns, without likely commensurate benefit for the animals in question. Small delphinoids are generally the most commonly observed marine mammals in the specific geographic region and would typically be the only marine mammals likely to intentionally approach the vessel. As described below, auditory injury is extremely unlikely to occur for mid-frequency cetaceans (*e.g.,* delphinids), as this group is relatively insensitive to sound produced at the predominant frequencies in an airgun pulse while also having a relatively high threshold for the onset of auditory injury (*i.e.,* permanent threshold shift). Please see ''Potential Effects of the Specified Activity on Marine Mammals'' later in this document for further discussion of sound metrics and thresholds and marine mammal hearing. A large body of anecdotal evidence indicates that small delphinoids commonly approach vessels and/or towed arrays during active sound production for purposes of bow riding, with no apparent effect observed in those delphinoids (*e.g.,* Barkaszi *et al.,* 2012). The increased shutdowns resulting from such a measure would require source vessels to revisit the missed track line to reacquire data, resulting in an overall increase in the total sound energy input to the marine environment and an increase in the total duration over which the survey is active in a given area. Although other mid-frequency hearing specialists (*e.g.,* large delphinoids) are no more likely to incur auditory injury than are small delphinoids, they are much less likely to approach vessels. Therefore, retaining a shutdown requirement for large delphinoids would not have similar impacts in terms of either practicability for the applicant or corollary increase in sound energy output and time on the water. We do anticipate some benefit for a shutdown requirement for large delphinoids in that it simplifies somewhat the total array of decision-making for PSOs and may preclude any potential for physiological effects other than to the auditory system as well as some more severe behavioral reactions for any such animals in close proximity to the source vessel.

BOEM's PEIS (BOEM, 2014a) provided modeling results for auditory injury zones on the basis of auditory injury criteria described by Southall *et al.* (2007). These zones were less than 10 m on the basis of maximum peak pressure, and a maximum of 18 m on the basis of cumulative sound exposure level (including application of relevant M-weighting filters). However, the recent finalization of NMFS's new technical acoustic guidance made these predictions irrelevant (NMFS, 2016). We calculated potential radial distances to auditory injury zones on the basis of maximum peak pressure using values provided by the applicants (Table 1) and assuming a simple model of spherical spreading propagation. These are as follows: Low-frequency cetaceans, 50–224 m; mid-frequency cetaceans, 14–63 m; and high-frequency cetaceans, 355–1,585 m. The 500-m radial distance of the standard exclusion zone is intended to be precautionary in the sense that it would be expected to contain sound exceeding peak pressure injury criteria for all hearing groups other than high-frequency cetaceans, while also providing a consistent, reasonably observable zone within which PSOs would typically be able to conduct effective observational effort. Although significantly greater distances may be observed from an elevated platform under good conditions, we believe that 500 m is likely regularly attainable for PSOs using the naked eye during typical conditions.

An appropriate exclusion zone based on cumulative sound exposure level (cSEL) criteria would be dependent on the animal's applied hearing range and how that overlaps with the frequencies produced by the sound source of interest (*i.e.,* via marine mammal auditory weighting functions) (NMFS, 2016), and may be larger in some cases than the zones calculated on the basis of the peak pressure thresholds (and larger than 500 m) depending on the species in question and the characteristics of the specific airgun array. In particular, it is likely that exclusion zone radii would be larger for low-frequency cetaceans, because their most susceptible hearing range overlaps the low frequencies produced by airguns, but that the zones would remain very small for mid-frequency cetaceans (*i.e.,* including the ''small delphinoids'' described above), whose range of best hearing largely does not overlap with frequencies produced by airguns. In order to more realistically incorporate the technical guidance's weighting functions over a seismic array's full acoustic band, we obtained unweighted spectrum data (modeled in 1 Hz bands) for a reasonably equivalent acoustic source (*i.e.,* a 36-airgun array with total volume of 6,600 in^3. Using these data, we made adjustments (dB) to the unweighted spectrum levels, by frequency, according to the weighting functions for each relevant marine mammal hearing group. We then converted these adjusted/weighted spectrum levels to pressures (micropascals) in order to integrate them over the entire broadband spectrum, resulting in broadband weighted source levels by hearing group that could be directly incorporated within NMFS's

User Spreadsheet (*i.e.,* override the Spreadsheet's more simple weighting factor adjustment). Using the User Spreadsheet's ''safe distance'' methodology for mobile sources (described by Sivle *et al.,* 2014) with the hearing group-specific weighted source levels, and inputs assuming spherical spreading propagation, a source velocity of 4.5 kn, shot intervals specified by the applicants, and pulse duration of 100 ms, we then calculated potential radial distances to auditory injury zones. These distances were smaller than those calculated on the basis of the peak pressure criterion, with the exception of the low-frequency cetacean hearing group (calculated zones range from 80–4,766 m). Therefore, our proposed 500-m exclusion zone contains the entirety of any potential injury zone for mid-frequency cetaceans, while the zones within which injury could occur may be larger for high-frequency cetaceans (on the basis of peak pressure and depending on the specific array) and for low-frequency cetaceans (on the basis of cumulative sound exposure). Only three species of high-frequency cetacean could occur in the proposed survey areas: the harbor porpoise and two species of the Family Kogiidae. Harbor porpoise are expected to occur rarely and only in the northern portion of the survey area. However, we propose a shutdown measure for *Kogia* spp. to address these potential injury concerns (described later in this section).

However, it is important to note that consideration of exclusion zone distances is inherently an essentially instantaneous proposition—a rule or set of rules that requires mitigation action upon detection of an animal. This indicates that consideration of peak pressure thresholds is most relevant, as compared with cumulative sound exposure level thresholds, as the latter requires that an animal accumulate some level of sound energy exposure over some period of time (*e.g.,* 24 hours). A PSO aboard a mobile source will typically have no ability to monitor an animal's position relative to the acoustic source over relevant time periods for purposes of understanding whether auditory injury is likely to occur on the basis of cumulative sound exposure and, therefore, whether action should be taken to avoid such potential. Therefore, definition of an exclusion zone based on cSEL thresholds is of questionable relevance given relative motion of the source and receiver (*i.e.,* the animal). Cumulative SEL thresholds are likely more relevant for purposes of modeling the potential for auditory injury than they are for informing real-time mitigation. We recognize the importance of the accumulation of sound energy to an understanding of the potential for auditory injury and that it is likely that, at least for low-frequency and high-frequency cetaceans, some potential auditory injury is likely impossible to mitigate and should be considered for authorization.

In summary, our intent in prescribing a standard exclusion zone distance is to (1) encompass zones for most species within which auditory injury could occur on the basis of instantaneous exposure; (2) provide additional protection from the potential for more severe behavioral reactions (*e.g.,* panic, antipredator response) for marine mammals at relatively close range to the acoustic source; (3) provide consistency for PSOs, who need to monitor and implement the exclusion zone; and (4) to define a distance within which detection probabilities are reasonably high for most species under typical conditions. Our use of 500 m as the zone is not based directly on any quantitative understanding of the range at which auditory injury would be entirely precluded or any range specifically related to disruption of behavioral patterns. Rather, we believe it is a reasonable combination of factors. This zone would contain all potential auditory injury for mid-frequency cetaceans, would contain all potential auditory injury for both low- and mid-frequency cetaceans as assessed against peak pressure thresholds (NMFS, 2016), and has been proven as a feasible measure through past implementation by operators in the Gulf of Mexico (GOM; as regulated by BOEM pursuant to the Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1331–1356)). In summary, a practicable criterion such as this has the advantage of familiarity and simplicity while still providing in most cases a zone larger than relevant auditory injury zones, given realistic movement of source and receiver. Increased shutdowns, without a firm idea of the outcome the measure seeks to avoid, simply displace seismic activity in time and increase the total duration of acoustic influence as well as total sound energy in the water (due to additional ramp-up and overlap where data acquisition was interrupted).

Shutdown of the acoustic source is also required (at any distance) in other circumstances:

- Upon observation of a right whale at any distance. Recent data concerning the North Atlantic right whale, one of the most endangered whale species (Best *et al.,* 2001), indicate uncertainty regarding the population's recovery and a possibility of decline (Kraus *et al.,* 2005; Waring *et al.,* 2016; Pettis and Hamilton, 2016). We believe it appropriate to eliminate potential effects to individual right whales to the extent possible.
- For TGS only, due to a high predicted amount of exposures (Table 10), we propose that shutdown be required upon observation of a fin whale at any distance. If the observed fin whale is within the behavioral harassment zone, it would still be considered to have experienced harassment, but by immediately shutting down the acoustic source the duration of harassment is minimized and the significance of the harassment event reduced as much as possible. This measure is not proposed for implementation by Spectrum, ION, CGG, or Western.
- Upon observation of a large whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult. Disturbance of cow-calf pairs, for example, could potentially result in separation of vulnerable calves from adults. Given the endangered status of most large whale species and the difficulty of correctly identifying some rorquals at greater distances, as well as the functional sensitivity of the mysticete whales to frequencies associated with the subject geophysical survey activity, we believe this measure is necessary.
- Upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel. Disturbance of deep-diving species such as sperm whales could result in avoidance behavior such as diving and, given their diving capabilities, it is possible that the vessel's course could take it closer to the submerged animals. As noted by Weir and Dolman (2007), a whale diving ahead of the source vessel within 2 km may remain on the vessel trackline until the ship approaches the whale's position before beginning horizontal movement. If undetected by PAM, it is possible that a shutdown might not be triggered and a severe behavioral response caused.
- Upon any observation (visual or acoustic) of a beaked whale or *Kogia* spp. Similar to the sperm whale measure described above, these species are deep divers and it is possible that disturbance could provoke a severe behavioral response leading to injury. Unlike the sperm whale, we recognize that there are generally low detection probabilities for beaked whales and *Kogia* spp., meaning that many animals of these species may go undetected. For

example, Barlow and Gisiner (2006) predict a roughly 24–48 percent reduction in the probability of detecting beaked whales during seismic mitigation monitoring efforts as compared with typical research survey efforts (Barlow (1999) estimates such probabilities at 0.23 to 0.45 for Cuvier's and Mesoplodont beaked whales, respectively). Similar detection probabilities have been noted for *Kogia* spp., though they typically travel in smaller groups and are less vocal, thus making detection more difficult (Barlow and Forney, 2007). As discussed later in this document (see ''Estimated Take by Incidental Harassment''), there are high levels of predicted exposures for beaked whales in particular. Because it is likely that only a small proportion of beaked whales and *Kogia* spp. potentially affected by the proposed surveys would actually be detected, it is important to avoid potential impacts when possible. Additionally for *Kogia* spp.—the one species of high-frequency cetacean likely to be encountered—auditory injury zones relative to peak pressure thresholds may range from approximately 350–1,500 m from the acoustic source, depending on the specific array characteristics (NMFS, 2016).

- Upon observation of an aggregation of marine mammals of any species that does not appear to be traveling. Under these circumstances, we assume that the animals are engaged in some important behavior (*e.g.,* feeding, socializing) that should not be disturbed. By convention, we define an aggregation as six or more animals. This definition may be modified on the basis of any new information presented that justifies a different assumption.

Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch; hand-held UHF radios are recommended. When both visual PSOs and PAM operators are on duty, all detections must be immediately communicated to the remainder of the on-duty team for potential verification of visual observations by the PAM operator or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the PAM operator is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdowns at any distance), a 30-minute clearance period must be observed following the last observation of the animal(s). We recognize that BOEM may require a longer clearance period (*e.g.,* 60 minutes). However, at typical survey speed of approximately 4.5 kn, the vessel would cover greater than 4 km during the 30-minute clearance period. Although some deep-diving species are capable of remaining submerged for periods up to an hour, it is unlikely that they would do so both while experiencing potential adverse reaction to the acoustic stimulus and remaining within the exclusion zone of the moving vessel. Extending the clearance period would not appreciably increase the likelihood of detecting the animals prior to reactivating the acoustic source.

If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. We define ''brief periods'' in keeping with other clearance watch periods and to avoid unnecessary complexity in protocols for PSOs. For any longer shutdown (*e.g.,* during line turns), pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

Power-Down

Power-down can be used either as a reverse ramp-up or may simply involve reducing the array to a single element or ''mitigation source,'' and has been allowed in past MMPA authorizations as a substitute for full shutdown. We address use of a mitigation source below. In a power-down scenario, it is assumed that turning off power to individual array elements reduces the size of the ensonified area such that an observed animal is then outside some designated area. However, we have no information as to the effect of powering down the array on the resulting sound field. In 2012, NMFS and BOEM held a monitoring and mitigation workshop focused on seismic survey activity. Industry representatives indicated that the end result may ultimately be increased sound input to the marine environment due to the need to re-shoot the trackline to prevent gaps in data acquisition (unpublished workshop report, 2012). For this reason and because a power-down may not actually be useful, our proposal requires full shutdown in all applicable circumstances; power-down is not allowed.

Mitigation Source

Mitigation sources may be separate individual airguns or may be an airgun of the smallest volume in the array, and are often used when the full array is not being used (*e.g.,* during line turns) in order to allow ramp-up during poor visibility. The general premise is that this lower-intensity source, if operated continuously, would be sufficiently aversive to marine mammals to ensure that they are not within an exclusion zone, and therefore, ramp-up may occur at times when pre-clearance visual watch is minimally effective. There is no information to suggest that this is an effective protective strategy, yet we are certain that this technique involves input of extraneous sound energy into the marine environment, even when use of the mitigation source is limited to some maximum time period. For these reasons, we do not believe use of the mitigation source is appropriate and do not propose to allow its use. However, as noted above, ramp-up may occur under periods of poor visibility assuming that no acoustic or visual detections are made during a 30-minute pre-clearance period. This is a change from how mitigation sources have been considered in the past in that the visual pre-clearance period is typically assumed to be highly effective during good visibility conditions and viewed as critical to avoiding auditory injury and, therefore, maintaining some likelihood of aversion through use of mitigation sources during poor visibility conditions is valuable.

In light of the available information, we think it more appropriate to acknowledge the limitations of visual observations—even under good conditions, not all animals will be observed and cryptic species may not be observed at all—and recognize that while visual observation is a common sense mitigation measure its presence should not be determinative of when survey effort may occur. Given the lack of proven efficacy of visual observation in preventing auditory injury, its absence should not imply such potentially detrimental impacts on marine mammals, nor should use of a mitigation source be deemed a sensible substitute component of seismic mitigation protocols. We also believe that consideration of mitigation sources in the past has reflected an outdated balance, in which the possible prevention of relatively few instances of auditory injury is outweighed by many more instances of unnecessary behavioral disturbance of animals and degradation of acoustic habitat.

Miscellaneous Protocols

The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source should be avoided. Firing of the acoustic source at any volume above the stated production volume is not authorized for these proposed IHAs; the operator must provide information to the lead PSO at regular intervals confirming the firing volume.

Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

We encourage the applicant companies and operators to pursue the following objectives in designing, tuning, and operating acoustic sources: (1) Use the minimum amount of energy necessary to achieve operational objectives (*i.e.,* lowest practicable source level); (2) minimize horizontal propagation of sound energy; and (3) minimize the amount of energy at frequencies above those necessary for the purpose of the survey. However, we are not aware of available specific measures by which to achieve such certifications. In fact, BOEM recently announced that an expert panel convened to determine whether it would be feasible to develop standards to determine a lowest practicable source level has determined that it would not be reasonable or practicable to develop such metrics (see Appendix L in BOEM, 2016b). Minimizing production of sound at frequencies higher than are necessary would likely require design, testing, and use of wholly different airguns than are proposed for use by the applicants. At minimum, notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented for reporting. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

There has been some attention paid to the establishment of minimum separation distances between operating source vessels, and BOEM may require a minimum 40-km geographic separation distance (BOEM, 2014b). The premise regarding this measure is either to provide a relatively noise-free corridor between vessels conducting simultaneous surveys such that animals may pass through rather than traveling larger distances to go around the source vessels or to reduce the cumulative sound exposure for an animal in a given location. There is no information supporting the effectiveness of this measure, and participants in a 2012 monitoring and mitigation workshop focused on seismic survey activity held by NMFS and BOEM were skeptical regarding potential efficacy of this measure (unpublished workshop report, 2012). Unintended consequences were a concern of some participants, including the possibility that converging sound fields could confuse animals and/or prevent egress from an area. In fact, it may be more effective as a protective measure to group acoustic sources as closely together as possible, in which case the SEL exposure would not be appreciably louder and an animal would have a better chance of avoiding exposure than through the supposed corridor (thus also potentially shortening total duration of sound exposure).

The desired effect of such a measure is too speculative and would impose additional burden on applicants. Therefore, we do not propose to require any minimum separation distance between source vessels. Operators do typically maintain a minimum separation of about 17.5 km between concurrent surveys to avoid interference (*i.e.,* overlapping reflections received from multiple source arrays) (BOEM, 2014a). As noted previously, TGS (the only company proposing to use two source vessels) plans to maintain a minimum separation of approximately 100 km between their own source vessels.

Closure Areas

Coastal Restriction—No seismic survey effort may occur within 30 km of the coast. The intent of this restriction is to provide additional protection for coastal stocks of bottlenose dolphin, all of which are designated as depleted under the MMPA because they were determined to be below their optimum sustainable population level (*i.e.,* the number of animals that will result in the maximum productivity of the population, keeping in mind the carrying capacity of their ecosystem). Already designated as depleted, an Unusual Mortality Event (UME) affected bottlenose dolphins along the Atlantic coast, from New York to Florida, from 2013–15. Genetic analyses performed to date indicate that 99 percent of dolphins impacted were of the coastal ecotype, which may be expected to typically occur within 20 km of the coast. A 10 km buffer is provided to encompass the area within which sound exceeding 160 dB rms would reasonably be expected to occur (see additional discussion in next section). Further discussion of this UME is provided under ''Description of Marine Mammals in the Area of the Specified Activity,'' later in this document.

The coastal form of bottlenose dolphin is known to occur further offshore than 20 km, but available information suggests that exclusion of harassing sound from a 20 km coastal zone would avoid the vast majority of impacts. There is generally a discontinuity in bottlenose dolphin distribution between nearshore areas inhabited by coastal ecotype dolphins and the deeper offshore waters inhabited by offshore ecotype dolphins (Kenney, 1990; Roberts *et al.,* 2016), with some possibility that this discontinuity represents habitat partitioning between bottlenose dolphins and Atlantic spotted dolphins (which occur in high density on the shelf in areas where there is generally low density of bottlenose dolphin). The separation between offshore and coastal morphotypes varies depending on location and season, with the ranges overlapping to some degree south of Cape Hatteras. Coastwide, systematic biopsy collection surveys were conducted during the summer and winter to evaluate the degree of spatial overlap between the two morphotypes. North of Cape Lookout, North Carolina, there was a clear discontinuity with coastal ecotype dolphins found in waters less than 20 m depth and offshore ecotype dolphins found in waters greater than 40 m depth. South of Cape Lookout, spatial overlap was found although the probability of a sampled group being from the coastal ecotype decreased with increasing depth (Garrison *et al.,* 2003). Prior to these surveys, coastal ecotype dolphins were provisionally assumed to occur within a spatial boundary of 27 km from shore for the region south of Cape Hatteras during winter and a boundary of 12 km from shore for the region north of Cape Hatteras during summer (Garrison, 2001 in Garrison *et al.,* 2003). Here, we adopt a coastwide 20 km spatial boundary for simplicity and under the assumption that it would contain the vast majority of coastal bottlenose dolphins.

Proposal of this measure should not be interpreted as NMFS's determination that harassment of coastal bottlenose dolphins cannot be authorized. However, when considering the likely benefit to the species against the impact to applicants, we believe that inclusion of this measure is warranted. Approximately 1,650 dolphin carcasses were recovered during the UME, and it is likely that many more dolphins died whose carcasses were not recovered. Considering just the known dead could represent greater than five percent of the pre-UME abundance for all coastal ecotype dolphins within the affected area. Ongoing areas of research related to the UME include understanding its impacts on the status of the affected stocks, as well as continuing monitoring and modeling designed to inform understanding of impacts on the surviving population. Given this uncertainty, a precautionary approach is warranted. We note that three applicants, Spectrum, CGG, and Western, do not propose to conduct survey effort within 30 km of the coast, and effort within 30 km for the other two applicants would represent a small fraction of overall survey effort.

North Atlantic Right Whale—We propose seasonal restriction of survey effort such that particular areas of expected importance for North Atlantic right whales are not ensonified by levels of sound expected to result in behavioral harassment, including designated critical habitat, vessel speed limit seasonal management areas (SMAs), a coastal strip containing SMAs, and vessel speed limit dynamic management areas (DMAs). Although right whales may also use areas farther offshore, these areas are expected to provide substantial protection of right whales within the migratory corridor and calving and nursery grounds and, when coupled with the absolute shutdown provision described previously for right whales, may reasonably be expected to eliminate most potential for behavioral harassment of right whales.

The North Atlantic right whale was severely depleted by historical whaling, and currently has a small population abundance (*i.e.,* less than 500 individuals) that is considered to be extremely low relative to the optimum sustainable population (Waring *et al.,* 2016). Surveys in recent years have detected an important shift in habitat use patterns, with fewer whales observed in feeding areas and counts for calves and adults on the southeastern calving grounds the lowest recorded since those surveys began (Waring *et al.,* 2016). At the same time, the current estimate of the minimum number of whales alive (as described in NMFS's draft 2016 stock assessment report) suggests that abundance has declined. While the authors caution that this apparent decrease should be interpreted with caution and in conjunction with apparent shifts in habitat use, it is possible that the population has declined. An increased number of carcasses were recovered in 2004–05, including six adult females. Kraus *et al.* (2005) determined that this mortality rate increase would reduce population growth by approximately ten percent per year, a trend not detected in subsequent years. Furthermore, the current annual estimate of anthropogenic mortality is over five times the potential biological removal level (see ''Description of Marine Mammals in the Area of the Specified Activity'' for further discussion of these concepts). The small population size and low annual reproductive rate of right whales suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales (Waring *et al.,* 2016). Given these considerations, and the likelihood that any disturbance of right whales is consequential, here we take a precautionary approach to mitigation.

Mid-Atlantic SMAs for vessel speed limits are in effect from November 1 through April 30, while southeast SMAs are in effect from November 15 through April 15 (see 50 CFR 224.105). However, as a precautionary approach all areas discussed here for proposed mitigation would be in effect from November 1 through April 30. Because we intend to use these areas to reduce the likelihood of exposing right whales to noise from airgun arrays that might result in harassment, we require that source vessels maintain a minimum standoff of 10 km from the area. Sound propagation modeling results provided for a notional large airgun array in BOEM's PEIS indicate that a 10 km distance would likely contain received levels of sound exceeding 160 dB rms under a wide variety of conditions (*e.g.,* 21 scenarios encompassing four depth regimes, four seasons, two bottom types). See Appendix D of BOEM's PEIS for more detail. The 95 percent ranges (*i.e.,* the radius of a circle encompassing 95 percent of grid points equal to or greater than the 160 dB threshold value) provided in Table D–22 of BOEM's PEIS range from 4,959–9,122 m, with mean of 6,838 m. Restricting scenario results to fall/winter and water depths <1,000 m reduces the number of relevant scenarios to six, with the range of radial distances from 8,083–8,896 m (mean of 8,454 m).

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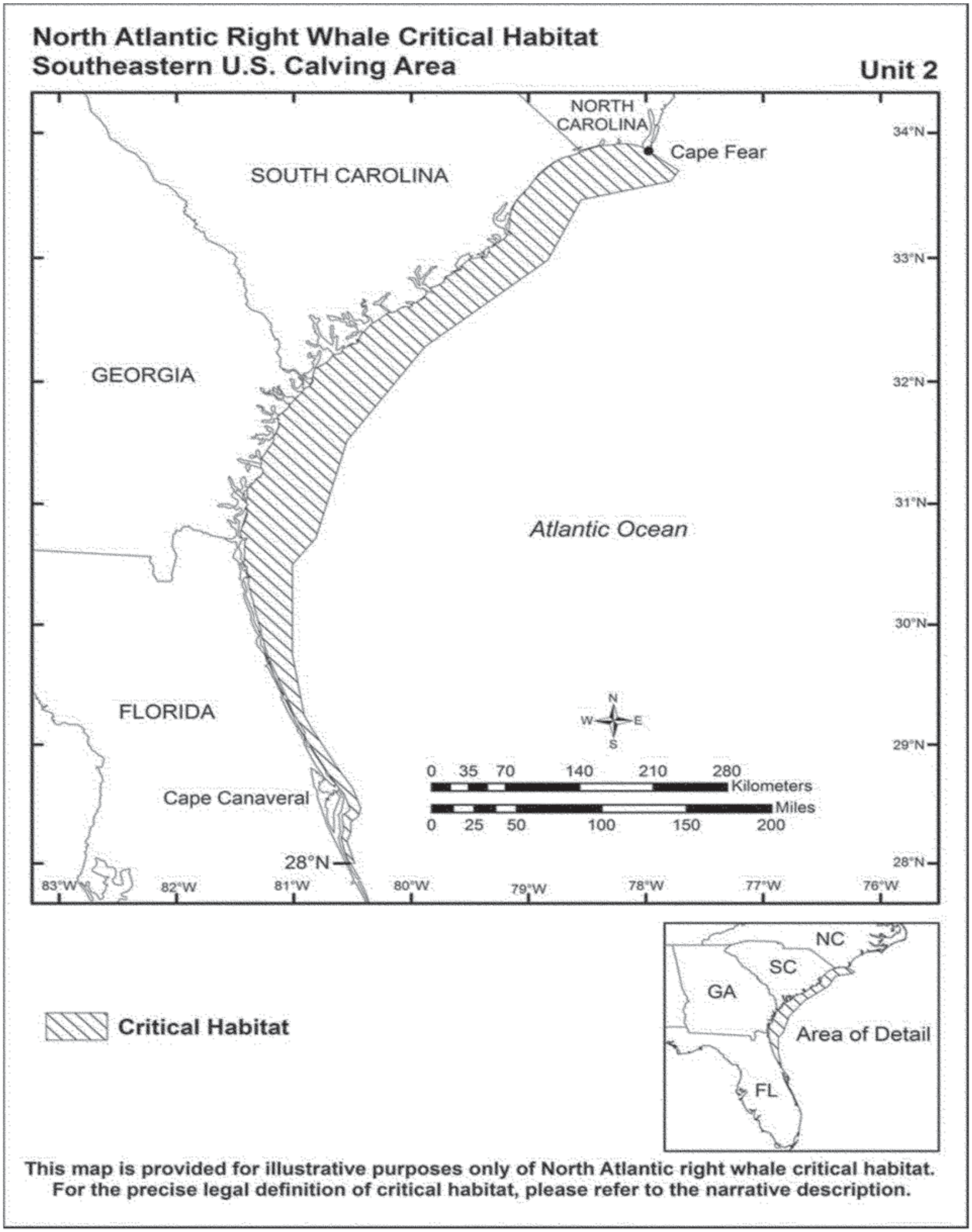

Figure 2. North Atlantic Right Whale Critical Habitat, Southeast U.S.

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The portion of critical habitat within the proposed survey area includes nearshore and offshore waters of the southeastern U.S., extending from Cape Fear, North Carolina south to 28° N. The specific area designated as critical habitat, as defined by regulation (81 FR 4838; January 27, 2016), is demarcated by rhumb lines connecting the specific points identified in Table 2. This area is depicted in Figure 2, and the restriction on survey effort within 10 km of this area would be in effect from November through April, when right whales are known to use the area.

A coastal strip containing all SMAs would also be avoided by a minimum standoff distance of 10 km, as would DMAs. These are areas in which right whales are likely to be present when such areas are in effect; mandatory or voluntary speed restrictions for certain vessels are in place in these areas respectively when in effect to reduce the risk of ship strike. Because these areas are intended to reduce the risk of ship strike involving right whales, they are designated in consideration of both right whale presence during migratory periods and commercial shipping traffic. Our concern is not limited to ship strike; therefore the standoff areas based on the SMAs are extended to a continuous coastal strip with a 10 km buffer. Mid-Atlantic SMAs (from Delaware to northern Georgia) are intended to protect whales on the migratory route and are generally defined as a 20 nmi (37 km) radial distance around the entrance to certain ports. Therefore, no survey effort may occur within 47 km of the coast between November and April. This strip is superseded where either designated critical habitat or the southeast SMA provides a larger restricted area. The southeast SMA, intended to protect whales on the calving and nursery grounds, includes the area bounded to the north by 31°27′ N., to the south by 29°45′ N., and to the east by 80°51′36″ W. No survey effort may occur within 10 km of this area between November and April. The combined area of our proposed restriction—composed of the greater of designated critical habitat, the 20 nmi coastal strip, and the southeastern SMA (all buffered by 10 km)—is depicted in Figure 3.

TABLE 2—BOUNDARIES OF DESIGNATED CRITICAL HABITAT FOR NORTH ATLANTIC RIGHT WHALES

Latitude	Longitude	Latitude	Longitude
33°51′ N.	At shoreline	29°08′ N.	80°51′ W.
33°42′ N.	77°43′ W.	28°50′ N.	80°39′ W.
33°37′ N.	77°47′ W.	28°38′ N.	80°30′ W.
33°28′ N.	78°33′ W.	28°28′ N.	80°26′ W.
32°59′ N.	78°50′ W.	28°24′ N.	80°27′ W.
32°17′ N.	79°53′ W.	28°21′ N.	80°31′ W.
31°31′ N.	80°33′ W.	28°16′ N.	80°31′ W.
30°43′ N.	80°49′ W.	28°11′ N.	80°33′ W.
30°30′ N.	81°01′ W.	28°00′ N.	80°29′ W.
29°45′ N.	81°01′ W.	28°00′ N.	At shoreline.
29°15′ N.	80°55′ W.		

Reproduced from 50 CFR 226.203(b)(2).

DMAs are also associated with a scheme established by the final rule for vessel speed limits (73 FR 60173; October 10, 2008; extended by 78 FR 73726; December 9, 2013) to reduce the risk of ship strike for right whales. In association with those regulations, NMFS established a program whereby vessels are requested, but not required, to abide by speed restrictions or avoid locations when certain aggregations of right whales are detected outside SMAs. Generally, the DMA construct is intended to acknowledge that right whales can occur outside of areas where they predictably and consistently occur due to, *e.g.,* varying oceanographic conditions that dictate prey concentrations. NMFS establishes DMAs by surveying right whale habitat and, when a specific aggregation is sighted, creating a temporary zone (*i.e.,* DMA) around the aggregation. DMAs are in effect for 15 days when designated and automatically expire at the end of the period, but may be extended if whales are re-sighted in the same area.

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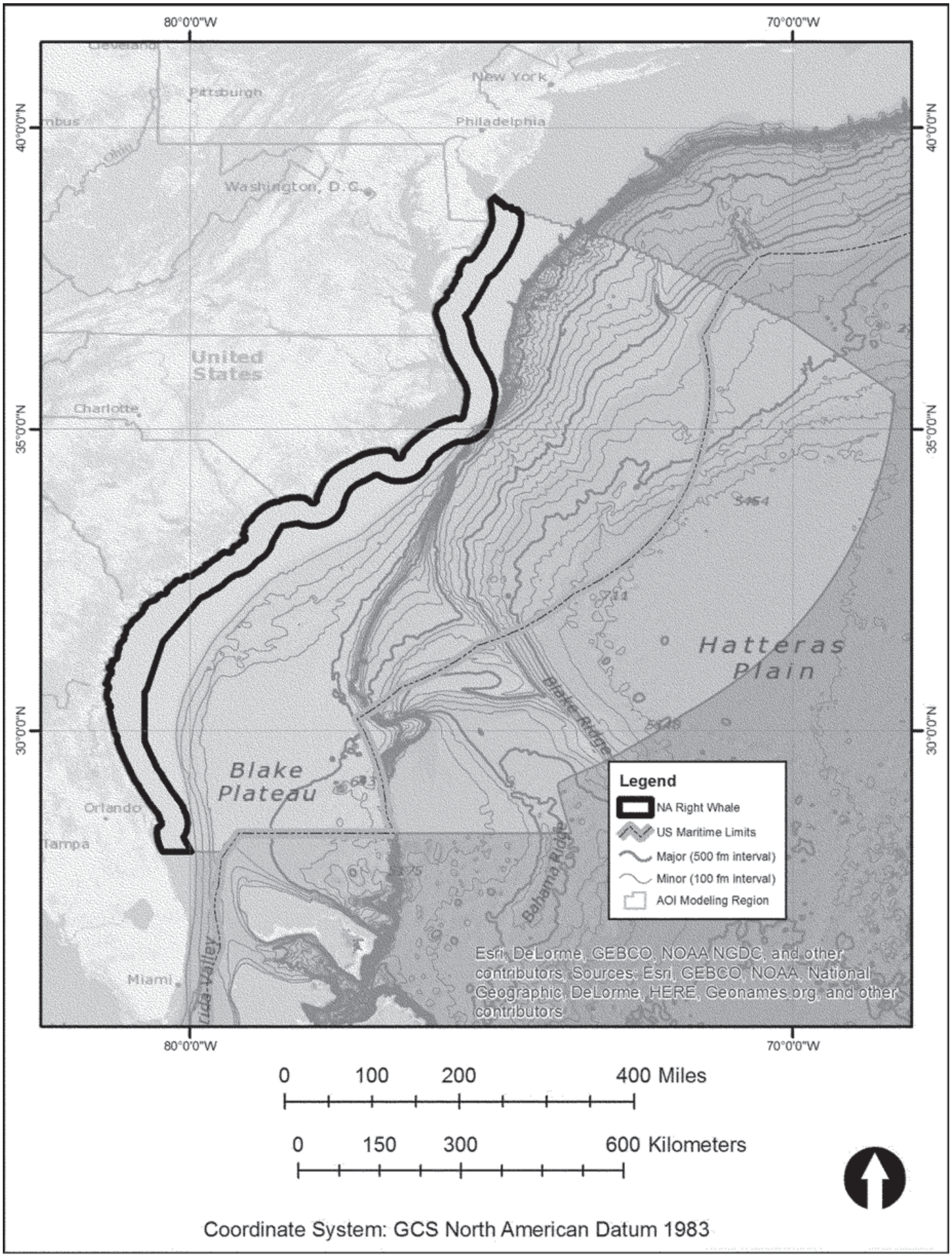

Figure 3. Proposed Time-area Restriction for North Atlantic Right Whale.

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Designation of DMAs follows certain protocols identified in 73 FR 60173 (October 10, 2008):

1. A circle with a radius of at least 3 nmi (5.6 km) is drawn around each observed group. This radius is adjusted for the number of right whales seen in the group such that the density of four right whales per 100 nmi^2 (185 km^2) is maintained. The length of the radius is determined by taking the inverse of the four right whales per 100 nmi^2 density (24 nmi^2 per whale). That figure is

equivalent to an effective radial distance of 3 nmi for a single right whale sighted, 4 nmi for two whales, 5 nmi for three whales, etc.

2. If any circle or group of contiguous circles includes three or more right whales, this core area and its surrounding waters become a candidate temporary zone. After NMFS identifies a core area containing three or more right whales, as described here, it will expand this initial core area to provide a buffer area in which the right whales could move and still be protected.

NMFS determines the extent of the DMA zone by:

3. Establishing a 15-nmi (27.8-km) radius from the sighting location used to draw a larger circular zone around each core area encompassing a concentration of right whales. The sighting location is the geographic center of all sightings on the first day of an event; and

4. Identifying latitude and longitude lines drawn outside but tangential to the circular buffer zone(s).

NMFS issues announcements of DMAs to mariners via its customary maritime communication media (*e.g.,* NOAA Weather radio, Web sites, email and fax distribution lists) and any other available media outlets. Information on the possibility of establishment of such zones is provided to mariners through written media such as *U.S. Coast Pilots* and *Notice to Mariners* including, in particular, information on the media mariners should monitor for notification of the establishment of a DMA. Upon notice via the above media of DMA designation, survey operators must cease operation if within 10 km of the boundary of a designated DMA and may not conduct survey operations within 10 km of a designated DMA during the period in which the DMA is active. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

Proposal of this measure should not be interpreted as NMFS's determination that harassment of right whales cannot be authorized. However, when considering the current status of the species, likely benefit of the measure to the species, and likely impact to applicants, we believe that inclusion of this measure is warranted.

Other Species—Predicted acoustic exposures are moderate to high for certain potentially affected marine mammal species (see Table 10) and, regardless of the absolute numbers of predicted exposures, the scope of proposed activities (*i.e.,* proposed survey activity throughout substantial portions of many species range and for substantial portions of the year) gives rise to concern regarding the impact on certain potentially affected stocks. Therefore, we take the necessary step of identifying additional spatiotemporal restrictions on survey effort, as described here (Figure 4 and Table 3). Our qualitative assessment leads us to believe that implementation of these measures is expected to provide both meaningful control on the numbers of animals affected as well as biologically meaningful benefit for the affected animals by restricting survey activity and the effects of the sound produced in areas of residency and/or preferred habitat that support higher densities for the stocks during substantial portions of the year.

The restrictions described here are primarily targeted towards protection of sperm whales, beaked whales (*i.e.,* Cuvier's beaked whale or *Mesoplodon* spp. but not the northern bottlenose whale; see ''Description of Marine Mammals in the Area of the Specified Activity''), Atlantic spotted dolphin, and pilot whales. For all four species or guilds, the amount of predicted exposures is moderate to high. For the Atlantic spotted dolphin, our impetus in delineating a restriction on survey effort is solely due to this high amount of predicted exposures to survey noise. For other species, the moderate to high amount of predicted exposures in conjunction with other contextual elements provides the impetus to develop appropriate restrictions. Beaked whales are considered to be a particularly acoustically sensitive species. The sperm whale is an endangered species, also considered to be acoustically sensitive and potentially subject to significant disturbance of important foraging behavior. Pilot whale populations in U.S. waters of the Atlantic are considered vulnerable due to high levels of mortality in commercial fisheries, and are therefore likely to be less resilient to other stressors, such as disturbance from the proposed surveys.

In some cases, we expect substantial subsidiary benefit for additional species that also find preferred habitat in the designated area of restriction. In particular, Area #5 (Figure 4), although delineated in order to specifically provide an area of anticipated benefit to beaked whales, sperm whales, and pilot whales, is expected to host a diverse cetacean fauna (*e.g.,* McAlarney *et al.,* 2015). Our analysis (described below) indicates that species most likely to derive subsidiary benefit from this time-area restriction include the bottlenose dolphin, Risso's dolphin, and common dolphin. For species with density predicted through stratified models, similar analysis is not possible and assumptions regarding potential benefit of time-area restrictions are based on known ecology of the species and sightings patterns and are less robust. Nevertheless, subsidiary benefit for Areas #2–4 (Figure 4) should be expected for species known to be present in these areas (*e.g.,* assumed affinity for slope/abyss areas off Cape Hatteras): *Kogia* spp., pantropical spotted dolphin, Clymene dolphin, and rough-toothed dolphin.

In order to consider potential restriction of survey effort in time and space, we considered the outputs of habitat-based predictive density models (Roberts *et al.,* 2016) as well as available information concerning focused marine mammal studies within the proposed survey areas, *e.g.,* photo-identification, telemetry, acoustic monitoring. The latter information was used primarily to provide verification for some of the areas and times considered, and helps to confirm that areas of high predicted density are in fact preferred habitat for these species. Please see ''Marine Mammal Density Information,'' later in this document, for a full description of the density models. We used the density model outputs by creating core abundance areas, *i.e.,* an area that contains some percentage of predicted abundance for a given species or species group. The purpose of a core abundance area is to represent the smallest area containing some percentage of the predicted abundance of each species. Summing all the cells (pixels) in the species distribution product gives the total predicted abundance. Core area is calculated by ranking cells by their abundance value from greatest to least, then summing cells with the highest abundance values until the total is equal to or greater than the specified percentage of the total predicted abundance. For example, if a 50 percent core abundance area is produced, half of the predicted abundance falls within the identified core area, and half occurs outside of it. In creating core abundance areas, we considered data outputs over the entire Atlantic coast scale rather than limiting to the proposed survey areas. This is appropriate because we are concerned with impacts to a stock as a whole, and therefore were interested in core abundance based on total predicted abundance rather than just abundance predicted over some subset of a stock's range. We were not able to consider core abundance areas for species with stratified models showing uniform density; however, this information informs us as to whether those species may receive subsidiary benefit from a given time-area restriction.

To determine core abundance areas, we follow a three-step process:

- Determine the predicted total abundance of a species/time period by adding up all cells of the density raster (grid) for the species/time period. For the Roberts *et al.* (2016) density rasters, density is specified as the number of animals per 100 km^2 cell.
- Sort the cells of the species/time period density raster from highest density to the lowest.
- Sum and select the raster cells from highest to lowest until a certain percentage of the total abundance is reached.

The selected cells represent the smallest area that represents a given percentage of abundance. We created a range of core abundance areas for each species of interest, but ultimately determined that 25 percent core abundance area was appropriate in most cases for our purpose. The larger the percentage of abundance captured, the larger the area. Generally speaking, we found that 25 percent core abundance provided the best balance between the areas given by larger (impracticably large areas for purposes of restricting survey effort) and smaller (ineffective areas for purposes of providing meaningful protection) areas. However, for sperm whales, our analysis showed that the 25 percent core abundance area covered a large portion of slope waters in the northern mid-Atlantic region and, therefore, what we believe to be an impracticably large area for potential restriction of survey effort. Although sperm whales are broadly distributed on the slope throughout the year, at the five percent core abundance threshold we found that the model predictions indicate a relatively restricted area of preferred habitat across all seasons in the vicinity of the shelf break to the north of Cape Hatteras. This area, together with spatially separated canyon features contained within the 25 percent core abundance areas and previously identified as preferred habitat for beaked whales, form the basis for our proposed time-space restriction for sperm whales. Core abundance maps are provided online at *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.*

In summary, we propose the following closure areas (depicted in Figure 4):

- In order to protect coastal bottlenose dolphins, a 30-km coastal strip (20 km plus 10 km buffer) would be closed to use of the acoustic source year-round.
- An area proposed for protection of the North Atlantic right whale (Figure 3). The area is comprised of the furthest extent at any location of three distinct components: (1) A 47-km coastal strip (20-nmi plus 10 km buffer) throughout the entire Mid- and South Atlantic OCS planning areas; (2) designated critical habitat, buffered by 10 km; and (3) the designated southeastern seasonal management area, buffered by 10 km. This area would be closed to use of the acoustic source from November through April. Dynamic management areas (buffered by 10 km) are also closed to use of the acoustic source when in effect.

The 10-km buffer (intended to reasonably prevent sound output from the acoustic source exceeding received levels expected to result in behavioral harassment from entering the proposed closure areas) is built into the areas defined below and in Table 3. Therefore, we do not separately mention the addition of the buffer.

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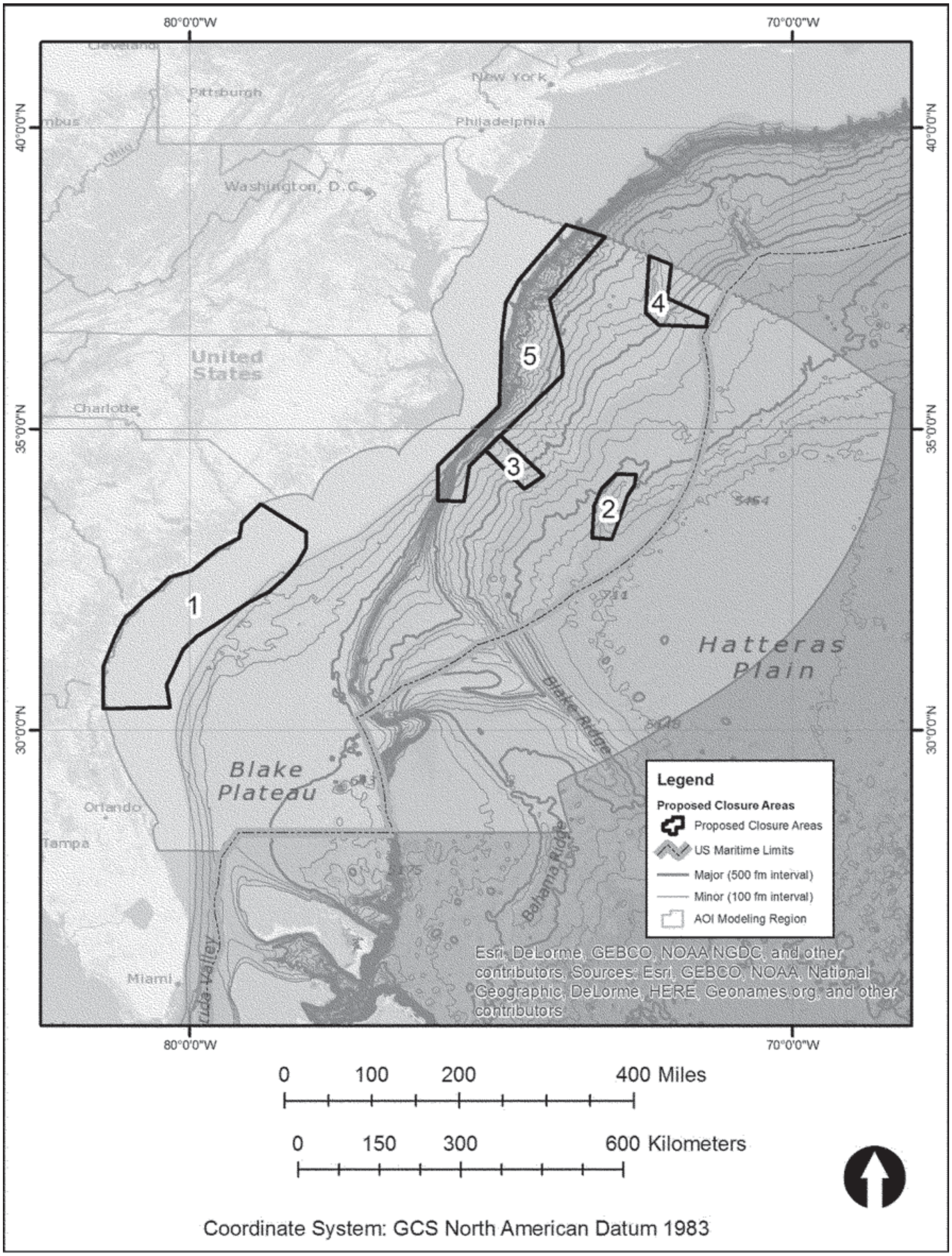

Figure 4. Proposed Time-area Restrictions.

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• An area proposed for protection of Atlantic spotted dolphin (Area #1, Figure 4). The area contains the on-shelf portion of a 25 percent core abundance area for the species, and is comprised of lines that demarcate the northern and southern extent of this area, connected by a line marking 100 km distance from shore (as indicated in Table 3). This area would be closed to use of the acoustic source from June through August. This restriction would not be required for ION or CGG.

• Deepwater canyon areas. Areas #2–4 (Figure 4) are proposed as defined in Table 3 and would be closed to use of the acoustic source year-round. Although they may be protective of additional species (*e.g., Kogia* spp.), Area #2 is expected to be particularly beneficial for beaked whales and Areas #3–4 are expected to be particularly beneficial for both beaked whales and sperm whales.

• Shelf break off Cape Hatteras and to the north, including slope waters around ''The Point.'' Area #5 is proposed as defined in Table 3 and would be closed to use of the acoustic source from July through September. Although this closure is expected to be beneficial for a diverse species assemblage, Area #5 is expected to be particularly beneficial for beaked whales, sperm whales, and pilot whales.

Beaked Whale

Beaked whales are typically deep divers, foraging for mesopelagic squid and fish, and are often found in deep water near high-relief bathymetric features, such as slopes, canyons, and escarpments where these prey are found (*e.g.,* Madsen *et al.,* 2014; MacLeod and D'Amico, 2006; Moors-Murphy, 2014). Sightings of Cuvier's beaked whale are almost exclusively in the continental shelf edge and continental slope areas, while *Mesoplodon* spp. sightings have occurred principally along the shelf-edge and deeper oceanic waters (CETAP, 1982; Waring *et al.,* 1992; Tove, 1995; Waring *et al.,* 2001; Hamazaki, 2002; Palka, 2006; Waring *et al.,* 2014). Roberts *et al.* (2016)'s results suggest that beaked whales do not undertake large seasonal migrations, and are therefore associated with significant habitat features year-round or with some degree of residency (Roberts *et al.,* 2015l; Gowans *et al.,* 2000; MacLeod and D'Amico, 2006). In support of patterns seen in the density model outputs, MacLeod and D'Amico (2006) state that beaked whale occurrence is linked particularly to features such as slopes, canyons, escarpments and oceanic islands. Northern bottlenose whales and Sowerby's beaked whales were found to preferentially occur in a marine canyon rather than the neighboring shelf, slope and abyssal areas (Hooker *et al.,* 1999, 2002). Cuvier's beaked whales are also known to associate with canyons (D'Amico *et al.,* 2003; Williams *et al.,* 1999), and Blainville's beaked whales were also found to preferentially occur over the upper reaches of a canyon (MacLeod and Zuur, 2005). Sighting rates of beaked whales in the western North Atlantic are significantly higher within canyon areas than non-canyon areas (Waring *et al.,* 2001). It is possible, however, that such occurrence patterns are linked more strongly to oceanographic features influencing prey distribution, which may or may not be permanently linked to seabed topography (MacLeod and D'Amico, 2006).

Submarine canyons are important features of the shelf and slope region from Cape Hatteras to the north, with both major and minor canyons abundant in the region. Roberts *et al.* (2016) predicted beaked whale density at year-round temporal resolution, with model predictions showing concentrated distribution in deep waters over high-relief bathymetry where high prey density would be expected due to entrainment of nutrient-rich sediments and organic material (Moors-Murphy, 2014). Highest densities were predicted in areas along the continental slope and in and around submarine canyons (Roberts *et al.,* 2016). The core abundance area analysis highlighted three such submarine canyon areas as being of year-round importance to beaked whales (Areas #2–4, see Figure 4). Area #3 is centered on Hatteras Canyon, a major canyon system that cuts a deep valley across the upper continental rise before terminating on the lower rise. Area #2, in deeper water, encompasses the Hatteras Transverse Canyon (HTC). HTC is downslope of and fed by both Hatteras and Albemarle Canyons (which dissect the slope) and their channel extensions, as well as smaller unnamed canyons and canyon channels, and is bounded by the Hatteras Ridge, which is a major transverse barrier deflecting turbidity currents into the HTC (Gardner *et al.,* 2016). Area #4 is centered on a large, deepwater valley system that is fed by a complex series of canyons and gullies incising the slope between Hendrickson and Baltimore Canyons (note that the entire shelf break north of Cape Hatteras, including many of these canyons and gullies, is included in our Area #5 (Figure 4) which is discussed below). In delineating the actual area proposed for restriction on survey effort, we expanded from 10 x 10 km grid cells specifically predicted as being within the beaked whale 25 percent core abundance area to include adjacent cells that also cover the relevant bathymetric feature. Assuming that beaked whales are present in these areas, their use of these habitat areas would not be expected to be restricted within the feature and we delineate the proposed closure areas accordingly. We assume that beaked whales associate with these features year-round, and each of the three areas is proposed as a year-round closure.

Area #5 (Figure 4) was designed as a multi-species area, primarily focused on pilot whales, beaked whales, and sperm whales. This area is focused on a particularly dynamic and highly productive environment off of Cape Hatteras (sometimes referred to as ''Hatteras Corner'' or ''The Point'') and the shelf break environment running to the north (to the boundary of BOEM's Mid-Atlantic OCS planning area) and to the south. This environment off of Cape Hatteras is created through the confluence of multiple currents and water masses, including the Gulf Stream (SAFMC, 2003), over complex bottom topography and hosts a high density and diversity of cetaceans (*e.g.,* McAlarney *et al.,* 2015). For beaked whales, our core abundance area analysis predicts that the shelf break area running from The Point to the southern extent of Area #5 would be within the 25 percent core abundance area, while the remainder of the shelf break to the north would be within the 50 percent core abundance area. This finding is supported by passive acoustic monitoring effort, which detected echolocation signals from Cuvier's beaked whales consistently throughout the year (95 percent of 741 recording days across all seasons), suggesting that beaked whales are resident to this area (Stanistreet *et al.,* 2015). Gervais' beaked whales were detected more sporadically (33 percent of recording days). Monthly aerial surveys conducted from 2011–2014 in the same region, from shallow continental shelf waters across the continental shelf break and into deep pelagic waters, also detected beaked whales in all months of the year (McLellan *et al.,* 2015). All beaked whale sightings occurred along the continental shelf break. Baird *et al.* (2015) reported results from three tagged Cuvier's beaked whales, which largely remained in slope waters off the coasts of North Carolina, Virginia, and Maryland. Although this limited number of tags makes it difficult to draw conclusions, the authors hypothesize that the observed movements may be representative of a resident population.

Although beaked whales are likely present in this area year-round, there is significant overlap between this proposed restriction and the area of highest interest by the applicant companies. Therefore, we determined that practicability concerns dictate that we establish a temporal component to this closure rather than designate this area as a year-round closure (as is the case for Areas #2–4). Roberts *et al.* (2016) predicted density for pilot whales and beaked whales at year-round temporal resolution; therefore, the output of those models does not help to designate a temporal aspect to this proposed restriction. However, the model produced for sperm whales predicts density at a monthly resolution and informed our delineation of temporal bounds for this closure. The model predicts the greatest density of sperm whales in this region from June through October, with the highest overall abundance predicted for July through September (Roberts *et al.,* 2015n). Therefore, we propose that Area #5 be in effect as a seasonal area closure from July through September.

Sperm Whale

Although sperm whales are one of the most widely distributed marine mammals, they are typically more abundant in areas of high primary productivity (Jaquet *et al.,* 1996) and thus may be expected to occur in greater numbers in areas where physiographic and oceanographic features serve to aggregate prey (*e.g.,* squid). Sperm whales are in fact commonly associated with submarine canyons (Moors-Murphy, 2014) and, specifically in this region, have been found to be associated with canyons (Whitehead *et al.,* 1992), the north wall of the Gulf Stream (Waring *et al.,* 1993), and temperature fronts and warm-core eddies (Waring *et al.,* 2001; Griffin, 1999). Areas #3–4 (Figure 4), described above for beaked whales, were also identified as areas of high predicted density for sperm whales. Roberts *et al.* (2016) predicted sperm whale density at monthly temporal resolution, and core abundance analysis conducted at a monthly time-step predicts that Area #3 is of year-round importance for sperm whales, while Area #4 is within the sperm whale 25 percent core abundance area for seven months of the year (Jun-Dec). CETAP (1982) reported sightings of sperm whales north of Cape Hatteras off the shelf and along the shelf break during all four seasons, while acoustic monitoring detected sperm whales every month of the year off the shelf near Onslow Bay, North Carolina (Stanistreet *et al.,* 2012; Hodge and Read, 2014; Debich *et al.,* 2014; Hodge *et al.,* 2015).

As noted above, Area #5 (Figure 4) is a multi-species area, primarily focused on pilot whales, beaked whales, and sperm whales, and is proposed to be in effect from July through September. In particular, Area #5's ''bulge'' to the north and east of Cape Hatteras was indicated as high-density sperm whale habitat contained within the five percent core abundance area in all months, but as a larger area and with higher predicted density during July through September, as discussed above. During these months, the 25 percent core abundance area for sperm whales is predicted as covering a large swath of the region from the region of The Point off and to the south of Cape Hatteras north to the planning area boundary and including shelf break waters east over the entire slope and into abyssal waters in some locations. As described previously, due to the large size of this area, we based this component of Area #5 on the relevant portion of the five percent core abundance are for sperm whales. This area, predicted to host the highest density of sperm whales, was contiguous to and somewhat overlapping with the shelf break strip suggested by core abundance area analysis for beaked whales and pilot whales. We believe this reflects the appropriate balance between necessary protective measures for this species and practicability for the applicant companies, which would be severely restricted in their ability to survey the area of interest were our proposed closure larger in terms of either space or time.

Pilot Whale

Pilot whales are distributed primarily along the continental shelf edge, occupying areas of high relief or submerged banks, and are also associated with the Gulf Stream wall and thermal fronts along the shelf edge (Waring *et al.,* 2016). Roberts *et al.* (2016) predicted pilot whale density at year-round temporal resolution. High pilot whale density was predicted throughout the year at an area of the shelf break and continental slope north of where the Gulf Stream separates from the shelf at Cape Hatteras. Sightings were reported in this vicinity in nearly every month of the year (Roberts *et al.,* 2015c).The entire shelf break area from Cape Hatteras north to the boundary of the planning area was predicted as being within the pilot whale 25 percent core abundance area. However, within this predicted core abundance area, the region immediately offshore of the Cape Hatteras shelf break and to the north extending into waters over the slope was predicted as containing notably higher density of pilot whales. This area is retained within the core abundance area even when the threshold is reduced to 5 percent, indicating that it is one of the most important areas in the region for any species. These patterns are supported by observation, including telemetry. Thorne *et al.* (2015) tracked the movements of 18 short-finned pilot whales off Cape Hatteras between May and December 2014 (mean tag deployment of 57 days) and quantified their habitat use relative to environmental variables. Results showed that pilot whales have a strong affinity for the shelf break, with more than 90 percent of locations occurring within 20 km of the shelf break (*i.e.,* 1,000 m depth contour) and more than 65 percent occurring within 5 km of the shelf break, and highlight the importance of static habitat features for the species. As a result of similar tagging work, Foley *et al.* (2015) found that, despite long-distance movements, pilot whales displayed a high degree of site fidelity off Cape Hatteras. Intra- and inter-annual as well as intra- and inter-seasonal matches to an existing photo-identification catalog were made, and some individuals were matched over periods of up to eight years. The authors hypothesize that that the shelf break offshore of Cape Hatteras is an important area for this species, to which individuals return frequently. Area #5 (Figure 4) was designed accordingly to encompass these important pilot whale habitat areas and, as described previously, is proposed to be in effect from July through September.

Atlantic Spotted Dolphin

Atlantic spotted dolphins are widely distributed in tropical and warm temperate waters of the western North Atlantic, and regularly occur in continental shelf waters south of Cape Hatteras and in continental shelf edge and continental slope waters north of this region (Payne *et al.,* 1984; Mullin and Fulling, 2003). Sightings have also been made along the north wall of the Gulf Stream and warm-core ring features (Waring *et al.,* 1992). This disjunct distribution may be due to the occurrence of two ecotypes of the species: A larger form that inhabits the continental shelf and is usually found inside or near the 200-m isobath and a smaller offshore form (Mullin and Fulling, 2003; Waring *et al.,* 2014). Morphometric, genetic, and acoustic data support the suggestion that two ecotypes inhabit this region (Baron *et al.,* 2008; Viricel and Rosel, 2014) and observational data are consistent with this distribution pattern. Existing data show a dense cluster of observations along the continental shelf between Florida and Virginia and a second, more dispersed cluster off the shelf and north of the Gulf Stream (north of Cape Hatteras) (Roberts *et al.,* 2015o). As would be expected from these patterns, results from Roberts *et al.* (2016) predict the following density pattern: Low near the shore, high in the mid-shelf, low near the shelf break, then higher again offshore.

Although there are no relevant considerations with regard to population context or specific stressors that lead us to develop mitigation focused on Atlantic spotted dolphins, the predicted amount of acoustic exposure for the species is among the highest for all species across three of the five applicant companies. Therefore, we believe it appropriate to delineate a time-area restriction for the sole purpose of reducing likely acoustic exposures for the species, for those three companies (*i.e.,* we propose that this restriction be implemented for Spectrum, TGS, and Western but not for CGG or ION). As noted above, observational data indicate that the area of likely highest density for Atlantic spotted dolphin is on-shelf south of Cape Hatteras. This is also an area of relatively little interest to the applicant companies (in contrast with the second area of relatively high density for Atlantic spotted dolphin, off the shelf to the north of the Gulf Stream). Our core abundance area analysis indeed suggests that the two areas comprise the 25 percent core abundance area for the species, with the on-shelf region roughly contained by the 100-m isobath offshore of Georgia and South Carolina. We thus delineate our proposed closure area by the northern and southern extent of the predicted on-shelf component of the 35 percent core abundance area, bounded by a line 100 km from shore (which roughly corresponds with the 100-m isobath). We assume that this may present a simpler, more practicable way for vessel operators to mark the area to be avoided, but invite public comment regarding operators' capacity to mark areas to be avoided using different methods (*e.g.,* coordinates, depth contours, specific distances from shore, shapefiles).

Our assumption here is that given the absence of other contextual factors demanding special protection of spotted dolphins, a seasonal restriction would be sufficient to guarantee that the species is afforded some protection from harassment in one of the areas most important for it. Because there is little information about the species migration patterns, and Roberts *et al.* (2016) predicted density at a year-round temporal resolution, we delineate the proposed closure on the basis of NMFS' observational data. Current shipboard observational data was collected during June-August 2011 (Waring *et al.,* 2014). Although Roberts *et al.* (2015o) suggest that monthly model results should not be relied upon, we note that these results do show likely highest abundance in this portion of the proposed survey areas in the summer months (June through September). Therefore, we propose that Area #1 be in effect from June through August.

TABLE 3—BOUNDARIES OF PROPOSED TIME-AREA RESTRICTIONS DEPICTED IN FIGURE 4

Area	Latitude	Longitude	Area	Latitude	Longitude
1	30° 20′ 50″ N.	At shoreline	4	36° 55′ 20″ N.	72° 26′ 18″ W.
1 [1]	30° 22′ 25″ N.	80° 19′ 55″ W.	4	37° 52′ 21″ N.	72° 22′ 31″ W.
1 [1]	33° 17′ 03″ N.	78° 04′ 00″ W.	4	37° 43′ 53″ N.	72° 00′ 32″ W.
1	33° 45′ 01″ N.	At shoreline	4	37° 43′ 54″ N.	72° 00′ 40″ W.
2	33° 31′ 16″ N.	72° 52′ 07″ W.	4	37° 09′ 52″ N.	72° 04′ 31″ W.
2	33° 10′ 05″ N.	72° 59′ 59″ W.	4	36° 52′ 01″ N.	71° 24′ 31″ W.
2	33° 11′ 23″ N.	73° 19′ 36″ W.	5	37° 08′ 30″ N.	74° 01′ 42″ W.
2	33° 43′ 34″ N.	73° 17′ 43″ W.	5	36° 15′ 12″ N.	73° 48′ 37″ W.
2	33° 59′ 43″ N.	73° 10′ 16″ W.	5	35° 53′ 14″ N.	73° 49′ 02″ W.
2	34° 15′ 10″ N.	72° 55′ 37″ W.	5	34° 23′ 07″ N.	75° 21′ 33″ W.
2	34° 14′ 02″ N.	72° 36′ 00″ W.	5	33° 47′ 37″ N.	75° 27′ 25″ W.
2	34° 03′ 33″ N.	72° 37′ 27″ W.	5	33° 48′ 31″ N.	75° 52′ 58″ W.
2	33° 53′ 00″ N.	72° 44′ 31″ W.	5	34° 23′ 57″ N.	75° 52′ 50″ W.
3	34° 13′ 21″ N.	74° 07′ 33″ W.	5	35° 22′ 29″ N.	74° 51′ 50″ W.
3	34° 00′ 07″ N.	74° 26′ 41″ W.	5	36° 32′ 31″ N.	74° 49′ 31″ W.
3	34° 38′ 40″ N.	75° 05′ 52″ W.	5	37° 05′ 39″ N.	74° 45′ 37″ W.
3	34° 53′ 24″ N.	74° 51′ 11″ W.	5	37° 27′ 53″ N.	74° 32′ 40″ W.
4	36° 41′ 17″ N.	71° 25′ 47″ W.	5	38° 23′ 15″ N.	73° 45′ 06″ W.
4	36° 43′ 20″ N.	72° 13′ 25″ W.	5	38° 11′ 17″ N.	73° 06′ 36″ W.

[1] These two points are connected by a line marking 100 km distance from shoreline.

National Marine Sanctuaries—As a result of consultation between BOEM and NOAA's Office of National Marine Sanctuaries, all surveys would maintain a minimum buffer of 15 km around the boundaries of the Gray's Reef and Monitor National Marine Sanctuaries. Gray's Reef NMS is located approximately 26 km off the Georgia coast and protects 57 km². The Monitor NMS is located approximately 26 km off the North Carolina coast and protects the wreck of the USS *Monitor.* Any benefit to marine mammals from these restrictions would likely be minimal.

Coastal Zone Management Act—As a result of coordination with relevant states pursuant to the Coastal Zone Management Act, Spectrum agreed to certain closure requirements (which may be partially or entirely subsumed by proposed closures described above):

- No survey operations within 125 nmi (232 km) of Maryland's coast from April 15 to November 15.
- No survey operations within the 30-m depth isobath off the South Carolina coast.
- No survey operations within 20 nmi (37 km) of Georgia's coast from April 1 to September 15 and within 30 nmi (56 km) of Georgia's coast from November 15 to April 15.

Vessel Strike Avoidance

These proposed measures generally follow those described in BOEM's PEIS. These measures apply to all vessels associated with the proposed survey activity (*e.g.,* source vessels, chase vessels, supply vessels) and include the following:

1. Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel, according to the parameters stated below, to ensure the potential for strike is minimized. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to

distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

2. All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15). See *www.fisheries.noaa.gov/pr/shipstrike/* for more information on these areas.

3. Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel. A single cetacean at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should be exercised when an animal is observed.

4. All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

a. While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

b. If a whale is spotted in the path of a vessel or within 500 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 500 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

5. All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

a. The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

b. If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

6. All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

General Measures

All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

We have carefully evaluated the suite of mitigation measures described here to preliminarily determine whether they are likely to effect the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another: (1) The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals, (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any mitigation measure(s) we prescribe should be able to accomplish, have a reasonable likelihood of accomplishing (based on current science), or contribute to the accomplishment of one or more of the general goals listed below:

(1) Avoidance or minimization of injury or death of marine mammals wherever possible (goals 2, 3, and 4 may contribute to this goal).

(2) A reduction in the number (total number or number at biologically important time or location) of individual marine mammals exposed to stimuli expected to result in incidental take (this goal may contribute to 1, above, or to reducing takes by behavioral harassment only).

(3) A reduction in the number (total number or number at biologically important time or location) of times any individual marine mammal would be exposed to stimuli expected to result in incidental take (this goal may contribute to 1, above, or to reducing takes by behavioral harassment only).

(4) A reduction in the intensity of exposure to stimuli expected to result in incidental take (this goal may contribute to 1, above, or to reducing the severity of behavioral harassment only).

(5) Avoidance or minimization of adverse effects to marine mammal habitat, paying particular attention to the prey base, blockage or limitation of passage to or from biologically important areas, permanent destruction of habitat, or temporary disturbance of habitat during a biologically important time.

(6) For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Based on our evaluation of these measures, we have preliminarily determined that they provide the means of effecting the least practicable impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

We recognize that BOEM may require more stringent measures through survey-specific permits issued to applicant companies under its authorities pursuant to the OCSLA (43 U.S.C. 1331–1356). NMFS's Endangered Species Act Interagency Cooperation Division (Interagency Cooperation Division) may also require that more stringent or additional measures be included in any issued IHAs via any required consultation pursuant to section 7 of the Endangered Species Act. Please see ''Proposed Authorizations,'' below, for requirements specific to each proposed IHA.

Description of Marine Mammals in the Area of the Specified Activity

We have reviewed the applicants' species descriptions—which summarize available information regarding status and trends, distribution and habitat preferences, behavior and life history, and auditory capabilities of the potentially affected species—for accuracy and completeness and refer the reader to Sections 3 and 4 of the applications, as well as to NMFS's Stock Assessment Reports (SAR; *www.nmfs.noaa.gov/pr/sars/*), instead of reprinting the information here. Additional general information about these species (*e.g.,* physical and behavioral descriptions) may be found on NMFS's Web site (*www.nmfs.noaa.gov/pr/species/mammals/*), in BOEM's PEIS, or in the U.S. Navy's Marine Resource Assessments (MRA) for relevant operating areas (*i.e.,* Virginia Capes, Cherry Point, and Charleston/Jacksonville (DoN, 2008a,b,c)). The MRAs are available online at: *www.navfac.navy.mil/products_and_services/ev/products_and_services/marine_resources/marine_resource_assessments.html.* Table 4 lists all species with expected potential for occurrence in the mid- and south Atlantic and summarizes information related to the population or stock, including potential biological removal (PBR). For taxonomy, we follow Committee on Taxonomy (2016). PBR, defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population, is considered in concert with known sources of ongoing anthropogenic mortality (as described in NMFS's SARs). Species that could potentially occur in the proposed survey areas but are not expected to have reasonable potential to be harassed by any proposed survey are described briefly but omitted from further analysis. These include extralimital species, which are species that do not normally occur in a given area but for which there are one or more occurrence records that are considered beyond the normal range of the species. For status of species, we provide information regarding U.S. regulatory status under the MMPA and ESA.

Marine mammal abundance estimates presented in this document represent the total number of individuals that make up a given stock or the total number estimated within a particular study area. NMFS's stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond U.S. waters. Survey abundance (as compared to stock or species abundance) is the total number of individuals estimated within the survey area, which may or may not align completely with a stock's geographic range as defined in the SARs. These surveys may also extend beyond U.S. waters.

In some cases, species are treated as guilds. In general ecological terms, a guild is a group of species that have similar requirements and play a similar role within a community. However, for purposes of stock assessment or abundance prediction, certain species may be treated together as a guild because they are difficult to distinguish visually and many observations are ambiguous. For example, NMFS's Atlantic SARs assess *Mesoplodon* spp. and *Kogia* spp. as guilds. Here, we consider pilot whales, beaked whales (excluding the northern bottlenose whale), and *Kogia* spp. as guilds. In the following discussion, reference to ''pilot whales'' includes both the long-finned and short-finned pilot whale, reference to ''beaked whales'' includes the Cuvier's, Blainville's, Gervais, Sowerby's, and True's beaked whales, and reference to ''*Kogia* spp.'' includes both the dwarf and pygmy sperm whale.

Thirty-four species (with 39 managed stocks) are considered to have the potential to co-occur with the proposed survey activities. Extralimital species or stocks unlikely to co-occur with survey activity include nine estuarine bottlenose dolphin stocks, four pinniped species, the white-beaked dolphin (*Lagenorhynchus albirostris*), and the beluga whale (*Delphinapterus leucas*). The white-beaked dolphin is generally found only to southern New England, with sightings concentrated in the Gulf of Maine and around Cape Cod. Beluga whales have rarely been sighted as far south as New Jersey, but are considered extralimital in New England. Seals in the western Atlantic are, in general, occurring more frequently in areas further south than are considered typical and increases in pinniped sightings and stranding events have been documented in the mid-Atlantic. However, all seals are considered rare or extralimital in the mid-Atlantic and, further, would generally be expected to occur in relatively shallow nearshore waters outside the proposed survey areas (note also that we propose a restriction on survey activity in coastal waters ranging from a minimum of 30 km (year-round) out to 47 km (November–April)). The gray seal's (*Halichoerus grypus grypus*) winter range extends south to New Jersey, while the harp seal (*Pagophilus groenlandicus*) is generally found in Canada, although individual seals are observed as far south as New Jersey during January–May. The harbor seal's (*Phoca vitulina concolor*) winter range is generally from southern New England to New Jersey, though it may occasionally extend south to northern North Carolina. Unpublished marine mammal stranding records for the most recent five-year period (2011–2015) for the Atlantic coast from Delaware to Georgia show 38, 24, and 44 strandings for these three species, respectively (with one additional record of an unidentified seal). These occurrences are generally limited to the mid-Atlantic (Delaware to North Carolina), with one harbor seal recorded from South Carolina and no records from Georgia. The hooded seal (*Cystophora cristata*) generally remains near Newfoundland in winter and spring, and visits the Denmark Strait for molting in summer. However, hooded seals are highly migratory, preferring deeper water than other seals, and individuals have been observed in deep water as far south as Florida and the Caribbean. Such observations are rare and unpredictable, and there were no recorded strandings of hooded seals during the 2011–2015 period.

Estuarine stocks of bottlenose dolphin primarily inhabit inshore waters of bays, sounds, and estuaries, and stocks are defined adjacent to the proposed survey area from Pamlico Sound, North Carolina to Indian River Lagoon, Florida. However, NMFS's SARs generally describe estuarine stock ranges as including coastal waters to 1 km (though North Carolina stocks are described as occurring out to 3 km at certain times of year). Therefore, these stocks would not be impacted by the proposed seismic surveys. In addition, the West Indian manatee (*Trichechus manatus latirostris*) may be found in coastal waters of the Atlantic. However, manatees are managed by the U.S. Fish and Wildlife Service and are not considered further in this document. All managed stocks in this region are assessed in NMFS's U.S. Atlantic SARs (*e.g.,* Waring *et al.,* 2016). All values presented in Table 4 are the most recent available at the time of publication and are available in the 2015 SARs (Waring *et al.,* 2016) and draft 2016 SARs (available online at: *www.nmfs.noaa.gov/pr/sars/draft.htm*).

TABLE 4—MARINE MAMMALS POTENTIALLY PRESENT IN THE VICINITY OF PROPOSED SURVEY ACTIVITIES

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [1]	NMFS stock abundance (CV, N_{min}, most recent abundance survey) [2]	Predicted abundance (CV) [3]	PBR	Annual M/SI (CV) [4]
Order Cetartiodactyla—Cetacea—Superfamily Mysticeti (baleen whales)							
Family Balaenidae							
North Atlantic right whale.	*Eubalaena glacialis*	Western North Atlantic (WNA).	E/D; Y	440 (n/a; 440; n/a)	*535 (0.45)	1.0	5.66
Family Balaenopteridae (rorquals)							
Humpback whale	*Megaptera novaeangliae novaeangliae.*	Gulf of Maine	-; N	823 (n/a; 823; 2008)	*1,637 (0.07)	13	9.05
Minke whale	*Balaenoptera acutorostrata acutorostrata.*	Canadian East Coast	-; N	2,591 (0.81; 1,425; 2011).	*2,112 (0.05)	14	8.25
Bryde's whale	*B. edeni brydei*	None defined [5]	-; n/a	n/a	7 (0.58)	n/a	n/a
Sei whale	*B. borealis borealis*	Nova Scotia	E/D; Y	357 (0.52; 236; 2011)	*717 (0.30)	0.5	0.8
Fin whale	*B. physalus physalus*	WNA	E/D; Y	1,618 (0.33; 1,234; 2011).	4,633 (0.08)	2.5	3.8
Blue whale	*B. musculus musculus*	WNA	E/D; Y	Unknown (n/a; 440; n/a).	11 (0.41)	0.9	Unk
Superfamily Odontoceti (toothed whales, dolphins, and porpoises)							
Family Physeteridae							
Sperm whale	*Physeter macrocephalus*	North Atlantic	E/D; Y	2,288 (0.28; 1,815; 2011).	5,353 (0.12)	3.6	0.8
Family Kogiidae							
Pygmy sperm whale.	*Kogia breviceps*	WNA	-; N	3,785 (0.47; 2,598; 2011) [6].	[6] 678 (0.23)	21	3.5 (1.0)
Dwarf sperm whale.	*K. sima*	WNA	-; N				
Family Ziphiidae (beaked whales)							
Cuvier's beaked whale.	*Ziphius cavirostris*	WNA	-; N	6,532 (0.32; 5,021; 2011).	[6] 14,491 (0.17)	50	0.4
Gervais beaked whale.	*Mesoplodon europaeus*	WNA	-; N	7,092 (0.54; 4,632; 2011) [6].		46	0.2
Blainville's beaked whale.	*M. densirostris*	WNA	-; N				
Sowerby's beaked whale.	*M. bidens*	WNA	-; N				
True's beaked whale.	*M. mirus*	WNA	-; N				
Northern bottlenose whale.	*Hyperoodon ampullatus*	WNA	-; N	Unknown	90 (0.63)	Undet.	0
Family Delphinidae							
Rough-toothed dolphin.	*Steno bredanensis*	WNA	-; N	271 (1.0; 134; 2011)	532 (0.36)	1.3	0
Common bottlenose dolphin.	*Tursiops truncatus truncatus.*	WNA Offshore	-; N	77,532 (0.40; 56,053; 2011).	[6] 97,476 (0.06)	561	39.4 (0.29)
		WNA Coastal, Northern Migratory.	D; Y	11,548 (0.36; 8,620; 2010–11).		86	1.0–7.5
		WNA Coastal, Southern Migratory.	D; Y	9,173 (0.46; 6,326; 2010–11).		63	0–12
		WNA Coastal, South Carolina/Georgia.	D; Y	4,377 (0.43; 3,097; 2010–11).		31	1.2–1.6
		WNA Coastal, Northern Florida.	D; Y	1,219 (0.67; 730; 2010–11).		7	0.4
		WNA Coastal, Central Florida.	D; Y	4,895 (0.71; 2,851; 2010–11).		29	0.2
Clymene dolphin	*Stenella clymene*	WNA	-; N	6,086 (0.93; 3,132; 1998) [7].	12,515 (0.56)	Undet.	0
Atlantic spotted dolphin.	*S. frontalis*	WNA	-; N	44,715 (0.43; 31,610; 2011).	55,436 (0.32)	316	0
Pantropical spotted dolphin.	*S. attenuata attenuata*	WNA	-; N	3,333 (0.91; 1,733; 2011).	4,436 (0.33)	17	0
Spinner dolphin	*S. longirostris longirostris*	WNA	-; N	Unknown	262 (0.93)	Undet.	0
Striped dolphin	*S. coeruleoalba*	WNA	-; N	54,807 (0.3; 42,804; 2011).	75,657 (0.21)	428	0
Short-beaked common dolphin.	*Delphinus delphis delphis*	WNA	-; N	70,184 (0.28; 55,690; 2011).	86,098 (0.12)	557	409 (0.10)
Fraser's dolphin	*Lagenodelphis hosei*	WNA	-; N	Unknown	492 (0.76)	Undet.	0

TABLE 4—MARINE MAMMALS POTENTIALLY PRESENT IN THE VICINITY OF PROPOSED SURVEY ACTIVITIES—Continued

Common name	Scientific name	Stock	ESA/MMPA status; strategic (Y/N) [1]	NMFS stock abundance (CV, N_{min}, most recent abundance survey) [2]	Predicted abundance (CV) [3]	PBR	Annual M/SI (CV) [4]
Atlantic white-sided dolphin.	*Lagenorhynchus acutus*	WNA	-; N	48,819 (0.61; 30,403; 2011).	37,180 (0.07)	304	74 (0.2)
Risso's dolphin	*Grampus griseus*	WNA	-; N	18,250 (0.46; 12,619; 2011).	7,732 (0.09)	126	53.6 (0.28)
Melon-headed whale.	*Peponocephala electra*	WNA	-; N	Unknown	1,175 (0.50)	Undet.	0
Pygmy killer whale	*Feresa attenuata*	WNA	-; N	Unknown	n/a	Undet.	0
False killer whale	*Pseudorca crassidens*	WNA	-; Y	442 (1.06; 212; 2011)	95 (0.84)	2.1	Unk
Killer whale	*Orcinus orca*	WNA	-; N	Unknown	11 (0.82)	Undet.	0
Short-finned pilot whale.	*Globicephala macrorhynchus*.	WNA	-; Y	21,515 (0.37; 15,913; 2011).	[6] 18,977 (0.11)	159	192 (0.17)
Long-finned pilot whale.	*G. melas melas*	WNA	-; Y	5,636 (0.63; 3,464; 2011).		35	38 (0.15)
Family Phocoenidae (porpoises)							
Harbor porpoise	*Phocoena phocoena phocoena*.	Gulf of Maine/Bay of Fundy.	-; N	79,833 (0.32; 61,415; 2011).	*45,089 (0.12)	706	437 (0.18)

[1] Endangered Species Act (ESA) status: Endangered (E), Threatened (T)/MMPA status: Depleted (D). A dash (-) indicates that the species is not listed under the ESA or designated as depleted under the MMPA. Under the MMPA, a strategic stock is one for which the level of direct human-caused mortality exceeds PBR or which is determined to be declining and likely to be listed under the ESA within the foreseeable future. Any species or stock listed under the ESA is automatically designated under the MMPA as depleted and as a strategic stock.

[2] NMFS marine mammal stock assessment reports online at: *www.nmfs.noaa.gov/pr/sars/*. CV is coefficient of variation; N_{min} is the minimum estimate of stock abundance. In some cases, CV is not applicable. For the right whale, the abundance value represents a count of individually identifiable animals; therefore there is only a single abundance estimate with no associated CV. For humpback whales, the stock abundance estimate of 823 is based on photo-identification evidence and represents the minimum number alive in 2008, specific to the Gulf of Maine stock. The minimum estimate of 440 blue whales represents recognizable photo-identified individuals.

[3] This information represents species- or guild-specific abundance predicted by recent habitat-based cetacean density models (Roberts *et al.,* 2016). These models provide the best available scientific information regarding predicted density patterns of cetaceans in the U.S. Atlantic Ocean, and we provide the corresponding abundance predictions as a point of reference. Total abundance estimates were produced by computing the mean density of all pixels in the modeled area and multiplying by its area. Roberts *et al.* (2016) did not produce a density model for pygmy killer whales off the east coast. For those species marked with an asterisk, the available information supported development of either two or four seasonal models; each model has an associated abundance prediction. Here, we report the maximum predicted abundance.

[4] These values, found in NMFS's SARs, represent annual levels of human-caused mortality plus serious injury from all sources combined (*e.g.,* commercial fisheries, ship strike). Annual M/SI often cannot be determined precisely and is in some cases presented as a minimum value or range. A CV associated with estimated mortality due to commercial fisheries is presented in some cases.

[5] Bryde's whales are occasionally reported off the southeastern U.S. and southern West Indies. NMFS defines and manages a stock of Bryde's whales believed to be resident in the northern Gulf of Mexico, but does not define a separate stock in the Atlantic Ocean.

[6] Abundance estimates are in some cases reported for a guild or group of species when those species are difficult to differentiate at sea. Similarly, the habitat-based cetacean density models produced by Roberts *et al.* (2016) are based in part on available observational data which, in some cases, is limited to genus or guild in terms of taxonomic definition. NMFS's SARs present pooled abundance estimates for *Kogia* spp. and *Mesoplodon* spp., while Roberts *et al.* (2016) produced density models to genus level for *Kogia* spp. and *Globicephala* spp. and as a guild for most beaked whales (*Ziphius cavirostris* and *Mesoplodon* spp.). Finally, Roberts *et al.* (2016) produced a density model for bottlenose dolphins that does not differentiate between offshore and coastal stocks.

[7] NMFS's abundance estimates for the Clymene dolphin is greater than eight years old and not considered current. PBR is therefore considered undetermined for this stock, as there is no current minimum abundance estimate for use in calculation. We nevertheless present the most recent abundance estimate.

For the majority of species potentially present in the specific geographic region, NMFS has designated only a single generic stock (*e.g.,* ''western North Atlantic'') for management purposes. This includes the ''Canadian east coast'' stock of minke whales, which includes all minke whales found in U.S. waters. For the humpback and sei whales, NMFS defines stocks on the basis of feeding locations, *i.e.,* Gulf of Maine and Nova Scotia, respectively. However, our reference to humpback whales and sei whales in this document refers to any individuals of the species that are found in the specific geographic region. For the bottlenose dolphin, NMFS defines an oceanic stock and multiple coastal stocks.

In Table 4 above, we report two sets of abundance estimates: Those from NMFS's SARs and those predicted by Roberts *et al.* (2016). Please see footnotes 2–3 for more detail. The estimates found in NMFS's SARs remain the best estimates of current stock abundance in most cases. These estimates are typically generated from the most recent shipboard and/or aerial surveys conducted, and often incorporate correction for detection bias. However, for purposes of assessing estimated exposures relative to abundance—used in this case to understand the scale of the predicted takes compared to the population and to inform our small numbers finding—we generally believe that the Roberts *et al.* (2016) abundance predictions are most appropriate because the outputs of these models were used in most cases to generate the exposure estimates and therefore provide the most appropriate comparison. The Roberts *et al.* (2016) abundance estimates represent the output of predictive models derived from observations and associated environmental parameters and are in fact based on substantially more data than are NMFS's SAR abundance estimates, which are typically derived from only the most recent survey effort. In some cases, the use of more data to inform an abundance estimate can lead to a conclusion that there may be a more appropriate abundance estimate to use for the specific comparison to exposure estimates noted above than that provided in the SARs. For example, NMFS's pilot whale abundance estimates show substantial year-to-year variability. For the Florida to Bay of Fundy region, single-year estimates from 2004 and 2011 (the most recent offered in the SARs) differed by 21 percent, indicating that it may be more appropriate to use the model prediction, as the model incorporates data from 1992–2013.

As a further illustration of the distinction between the SARs and model-predicted abundance estimates, the current NMFS stock abundance estimate for the Atlantic spotted dolphin is based on direct observations from shipboard and aerial surveys conducted in 2011 and corrected for detection bias whereas the exposure estimates presented herein for Atlantic spotted dolphin are based on the abundance predicted by a density surface model informed by observations from 1992–2014 and covariates associated at the observation level. To directly compare the estimated exposures predicted by the outputs of the Roberts *et al.* (2016) model to NMFS's SAR abundance would therefore not be meaningful. However, our use of the Roberts *et al.* (2016) abundance predictions for this purpose should not be interpreted as a statement that those predictions are considered to be more accurate than those presented in NMFS's SARs; rather they are a different set of information entirely and more appropriate, at times, for our analysis. For the example of Atlantic spotted dolphin, we make relative comparisons between the exposures predicted by the outputs of the model and the overall abundance predicted by the model. The best current abundance estimate for the western North Atlantic stock of Atlantic spotted dolphins is still appropriately considered to be that presented in the SAR. Where there are other considerations that lead us to believe that an abundance other than that predicted by Roberts *et al.* (2016) is most appropriate for use here, we provide additional discussion below.

NMFS's abundance estimate for the North Atlantic right whale is based on a census of individual whales identified using photo-identification techniques and is therefore the most appropriate abundance estimate; the current estimate represents whales known to be alive in 2012 (*www.nmfs.noaa.gov/pr/sars/draft.htm*).

The 2007 Canadian Trans-North Atlantic Sighting Survey (TNASS), which provided full coverage of the Atlantic Canadian coast (Lawson and Gosselin, 2009), provided abundance estimates for multiple stocks. The abundance estimates from this survey were corrected for perception and availability bias, when possible. In general, where the TNASS survey effort provided superior coverage of a stock's range (as compared with NOAA shipboard survey effort), we elect to use the resulting abundance estimate over either the current NMFS abundance estimate (derived from survey effort with inferior coverage of the stock range) or the Roberts *et al.* (2016) prediction. The TNASS data were not made available to the model authors (Roberts *et al.,* 2015a).

We use the TNASS abundance estimate for the Canadian North Atlantic stock of minke whales and for the short-beaked common dolphin. The TNASS survey also produced an abundance estimate of 3,522 (CV = 0.27) fin whales. Although Waring *et al.* (2016) suggest that the current abundance estimate of 1,618 fin whales, derived from 2011 NOAA shipboard surveys, is the best because it represents the most current data (despite not including a significant portion of the stock's range), we believe the TNASS estimate is most appropriate for use here precisely because it better covered the stock's range. Note that, while the same TNASS survey produced an abundance estimate of 2,612 (CV = 0.26) humpback whales, the survey did not provide superior coverage of the stock's range in the same way that it did for minke and fin whales (Waring *et al.,* 2016; Lawson and Gosselin, 2011). In addition, based on photo-identification only 39 percent of individual humpback whales observed along the mid- and south Atlantic U.S. coast are from the Gulf of Maine stock (Barco *et al.,* 2002). Therefore, we use the Roberts *et al.* (2016) prediction for humpback whales.

The TNASS also provided an abundance estimate for pilot whales (16,058; CV = 0.79), but covered habitats expected to contain long-finned pilot whales exclusively (Waring *et al.,* 2016). Pilot whale biopsy samples collected from 1998–2007 and analyzed to support an analysis of the likelihood that a sample is from a given species of pilot whale as a function of sea surface temperature and water depth showed that all pilot whales observed in offshore waters near the Gulf Stream are most likely short-finned pilot whales, though there is an area of overlap between the two species primarily along the shelf break off the coast of New Jersey (between 38–40° N.) (Waring *et al.,* 2016). Therefore, most pilot whales potentially affected by the proposed surveys would likely be short-finned pilot whales.

NMFS's current abundance estimate for *Kogia* spp. is substantially higher than that provided by Roberts *et al.* (2016). However, the data from which NMFS's estimate is derived was not made available to the authors (Roberts *et al.,* 2015h), and those more recent surveys reported observing substantially greater numbers of *Kogia* spp. than did earlier surveys (43 sightings, more than the combined total of 31 reported from all surveys from 1992–2014 considered by Roberts *et al.* (2016)) (NMFS, 2011). A 2013 NOAA survey, also not available to the model authors, reported 68 sightings of *Kogia* spp. (NMFS, 2013a). In addition, the SARs report an increase in *Kogia* spp. strandings (92 from 2001–05; 187 from 2007–11) (Waring *et al.,* 2007; 2013). A simultaneous increase in at-sea observations and strandings suggests increased abundance of *Kogia* spp., though NMFS has not conducted any trend analysis (Waring *et al.,* 2013). Therefore, we believe the most appropriate abundance estimate for use here is that currently reported by NMFS. In fact, Waring *et al.* (2013) suggest that because this estimate was corrected for perception bias but not availability bias, the true estimate could be two to four times larger.

Biologically Important Areas—Several biologically important areas for marine mammals are recognized from proposed survey areas in the mid- and south Atlantic. As referenced previously under ''Proposed Mitigation'', critical habitat is designated for the North Atlantic right whale within the southeast U.S. (81 FR 4838; January 27, 2016). Critical habitat is defined by section 3 of the ESA as (1) the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination by the Secretary that such areas are essential for the conservation of the species. Critical habitat for the right whale in the southeast U.S. (*i.e.,* Unit 2) encompasses calving habitat and is designated on the basis of the following essential features: (1) Calm sea surface conditions of Force 4 or less on the Beaufort Wind Scale; (2) sea surface temperatures from a minimum of 7 °C, and never more than 17 °C; and (3) water depths of 6 to 28 m, where these features simultaneously co-occur over contiguous areas of at least 231 nmi^2 of ocean waters during the months of November through April. When these features are available, they are selected by right whale cows and calves in dynamic combinations that are suitable for calving, nursing, and rearing, and which vary, within the ranges specified, depending on factors such as weather and age of the calves. The specific area associated with such features and designated as critical habitat was described previously under ''Proposed Mitigation.'' There is no critical habitat designated for any other species within the proposed survey area.

Biologically important areas for North Atlantic right whales in the mid- and south Atlantic were further described by LaBrecque *et al.* (2015). The authors describe an area of importance for reproduction that somewhat expands the boundaries of the critical habitat designation, including waters out to the 25-m isobath from Cape Canaveral to Cape Lookout from mid-November to mid-April, on the basis of habitat analyses (Good, 2008; Keller *et al.,*

2012) and sightings data (*e.g.,* Keller *et al.,* 2006; Schulte and Taylor, 2012) indicating that sea surface temperatures between 13 to 15 °C and water depths between 10–20 m are critical parameters for calving. Right whales leave northern feeding grounds in November and December to migrate along the continental shelf to the calving grounds or to unknown winter areas before returning to northern areas by late spring. Right whales are known to travel along the continental shelf, but it is unknown whether they use the entire shelf area or are restricted to nearshore waters (Schick *et al.,* 2009; Whitt *et al.,* 2013). LaBrecque *et al.* (2015) define an important area for migratory behavior on the basis of aerial and vessel-based survey data, photo-identification data, radio-tracking data, and expert judgment; we compared our composite right whale closure area (described previously under ''Proposed Mitigation'') in a GIS to that defined by the authors and found that it is contained within our area.

As noted by LaBrecque *et al.* (2015), although additional cetacean species are known to have strong links to bathymetric features, there is currently insufficient information to specifically identify these areas. For example, pilot whales and Risso's dolphins aggregate at the shelf break in the proposed survey area, and Atlantic spotted dolphins occupy the shelf region from southern Virginia to Florida. These and other locations predicted as areas of high abundance (Roberts *et al.,* 2016) form the basis of proposed spatiotemporal restrictions on survey effort as described under ''Proposed Mitigation.'' In addition, other data indicate potential areas of importance that are not yet fully described. Risch *et al.* (2014) describe minke whale presence offshore of the shelf break (evidenced by passive acoustic recorders), which may be indicative of a migratory area, while other data provides evidence that sei whales aggregate near meandering frontal eddies over the continental shelf in the Mid-Atlantic Bight (Newhall *et al.,* 2012).

Unusual Mortality Events (UME)—A UME is defined under the MMPA as ''a stranding that is unexpected; involves a significant die-off of any marine mammal population; and demands immediate response.'' From 1991 to the present, there have been approximately ten formally recognized UMEs affecting marine mammals in the proposed survey area and involving species under NMFS's jurisdiction. One involves ongoing investigation. The most recent of these, which is ongoing, involves humpback whales. A recently ended UME involved bottlenose dolphins.

Since January 2016, elevated humpback whale mortalities have occurred along the Atlantic coast from Maine through North Carolina. Partial or full necropsy examinations have been conducted on approximately half of the 42 known cases. Of the 20 cases examined, 10 cases had evidence of blunt force trauma or pre-mortem propeller wounds indicative of vessel strike, which is over six times above the 16-year average of 1.5 whales showing signs of vessel strike in this region. Because this finding of pre-mortem vessel strike is not consistent across all of the whales examined, more research is needed. NOAA is consulting with researchers that are conducting studies on the humpback whale populations, and these efforts may provide information on changes in whale distribution and habitat use that could provide additional insight into how these vessel interactions occurred. Three previous UMEs involving humpback whales have occurred since 2000, in 2003, 2005, and 2006. More information is available at *www.nmfs.noaa.gov/pr/health/mmume/2017humpbackatlanticume.html* (accessed May 22, 2017).

Beginning in July 2013, elevated strandings of bottlenose dolphins were observed along the Atlantic coast from New York to Florida. The investigation was closed in 2015, with the UME ultimately being attributed to cetacean morbillivirus (though additional contributory factors are under investigation; *www.nmfs.noaa.gov/pr/health/mmume/midatldolphins2013.html*; accessed June 21, 2016). Dolphin strandings during 2013–15 were greater than six times higher than the average from 2007–12, with the most strandings reported from Virginia, North Carolina, and Florida. A total of approximately 1,650 bottlenose dolphins stranded from June 2013 to March 2015 and, additionally, a small number of individuals of several other cetacean species stranded during the UME and tested positive for morbillivirus (humpback whale, fin whale, minke whale, pygmy sperm whale, and striped dolphin). Only one offshore ecotype dolphin has been identified, meaning that over 99 percent of affected dolphins were of the coastal ecotype (D. Fauquier; pers. comm.). Research, to include analyses of stranding samples and post-UME monitoring and modeling of surviving populations, will continue in order to better understand the impacts of the UME on the affected stocks. Notably, an earlier major UME in 1987–88 was also caused by morbillivirus. Over 740 stranded dolphins were recovered during that event.

Additional recent UMEs include various localized events with undetermined cause involving bottlenose dolphins (*e.g.,* South Carolina in 2011; Virginia in 2009); an event affecting common dolphins and Atlantic white-sided dolphins from North Carolina to New Jersey (2008; undetermined); and humpback whales in the North Atlantic (2006; undetermined). For more information on UMEs, please visit: *www.nmfs.noaa.gov/pr/health/mmume/.*

Take Reduction Planning—Take reduction plans are designed to help recover and prevent the depletion of strategic marine mammal stocks that interact with certain U.S. commercial fisheries, as required by Section 118 of the MMPA. The immediate goal of a take reduction plan is to reduce, within six months of its implementation, the mortality and serious injury of marine mammals incidental to commercial fishing to less than the potential biological removal level. The long-term goal is to reduce, within five years of its implementation, the mortality and serious injury of marine mammals incidental to commercial fishing to insignificant levels, approaching a zero serious injury and mortality rate, taking into account the economics of the fishery, the availability of existing technology, and existing state or regional fishery management plans. Take reduction teams are convened to develop these plans.

There are several take reduction plans in place for marine mammals in the proposed survey areas of the mid- and south Atlantic. We described these here briefly in order to fully describe, in conjunction with referenced material, the baseline conditions for the affected marine mammal stocks. The Atlantic Large Whale Take Reduction Plan (ALWTRP) was implemented in 1997 to reduce injuries and deaths of large whales due to incidental entanglement in fishing gear. The ALWTRP is an evolving plan that changes as we learn more about why whales become entangled and how fishing practices might be modified to reduce the risk of entanglement. It has several components, including restrictions on where and how gear can be set and requirements for entangling gears (*i.e.,* trap/pot and gillnet gears). The ALWTRP addresses those species most affected by fishing gear entanglements, *i.e.,* North Atlantic right whale, humpback whale, fin whale, and minke whale. Annual human-caused mortality exceeds PBR for the first three of these species, all of which are listed as endangered under the ESA. More information is available online at: *www.greateratlantic.fisheries.noaa.gov/protected/whaletrp/.*

NMFS implemented a Harbor Porpoise Take Reduction Plan (HPTRP) to reduce interactions between harbor porpoise and commercial gillnet gear in both New England and the mid-Atlantic. The HPTRP has several components including restrictions on where, when, and how gear can be set, and in some areas requires the use of acoustic deterrent devices. More information is available online at: *www.greateratlantic.fisheries.noaa.gov/protected/porptrp/.*

The Atlantic Trawl Gear Take Reduction Team was developed to address the incidental mortality and serious injury of pilot whales, common dolphins, and white-sided dolphins incidental to Atlantic trawl fisheries. More information is available online at: *www.greateratlantic.fisheries.noaa.gov/Protected/mmp/atgtrp/.* Separately, NMFS established a Pelagic Longline Take Reduction Plan (PLTRP) to address the incidental mortality and serious injury of pilot whales in the mid-Atlantic region of the Atlantic pelagic longline fishery. The PLTRP includes a special research area, gear modifications, outreach material, observer coverage, and captains' communications. Pilot whales incur substantial incidental mortality and serious injury due to commercial fishing (annual human-caused mortality equal to 121 and 109 percent of PBR for short- and long-finned pilot whales, respectively), and therefore are of particular concern. More information is available online at: *www.nmfs.noaa.gov/pr/interactions/trt/pl-trt.html.*

Potential Effects of the Specified Activity on Marine Mammals

This section includes a summary and discussion of the ways that components of the specified activity may impact marine mammals and their habitat. The ''Estimated Take by Incidental Harassment'' section later in this document will include a quantitative analysis of the number of individuals that are expected to be taken by this activity. The ''Negligible Impact Analyses'' section will include an analysis of how these specific activities will impact marine mammals and will consider the content of this section, the ''Estimated Take by Incidental Harassment'' section, and the ''Proposed Mitigation'' section, to draw conclusions regarding the likely impacts of these activities on the reproductive success or survivorship of individuals and from that on the affected marine mammal populations or stocks. In the following discussion, we provide general background information on sound and marine mammal hearing before considering potential effects to marine mammals from ship strike and sound produced through use of airgun arrays.

Description of Active Acoustic Sound Sources

This section contains a brief technical background on sound, the characteristics of certain sound types, and on metrics used in this proposal inasmuch as the information is relevant to the specified activity and to a discussion of the potential effects of the specified activity on marine mammals found later in this document.

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in hertz (Hz) or cycles per second. Wavelength is the distance between two peaks or corresponding points of a sound wave (length of one cycle). Higher frequency sounds have shorter wavelengths than lower frequency sounds, and typically attenuate (decrease) more rapidly, except in certain cases in shallower water. Amplitude is the height of the sound pressure wave or the ''loudness'' of a sound and is typically described using the relative unit of the decibel (dB). A sound pressure level (SPL) in dB is described as the ratio between a measured pressure and a reference pressure (for underwater sound, this is 1 microPascal (μPa)), and is a logarithmic unit that accounts for large variations in amplitude; therefore, a relatively small change in dB corresponds to large changes in sound pressure. The source level (SL) represents the SPL referenced at a distance of 1 m from the source (referenced to 1 μPa), while the received level is the SPL at the listener's position (referenced to 1 μPa).

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Rms is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1983). Rms accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

Sound exposure level (SEL; represented as dB re 1 μPa^2-s) represents the total energy contained within a pulse, and considers both intensity and duration of exposure. Peak sound pressure (also referred to as zero-to-peak sound pressure or 0-p) is the maximum instantaneous sound pressure measurable in the water at a specified distance from the source, and is represented in the same units as the rms sound pressure. Another common metric is peak-to-peak sound pressure (pk-pk), which is the algebraic difference between the peak positive and peak negative sound pressures. Peak-to-peak pressure is typically approximately 6 dB higher than peak pressure (Southall *et al.,* 2007).

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in a manner similar to ripples on the surface of a pond and may be either directed in a beam or beams or may radiate in all directions (omnidirectional sources), as is the case for pulses produced by the airgun arrays considered here. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones.

Even in the absence of sound from the specified activity, the underwater environment is typically loud due to ambient sound. Ambient sound is defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995), and the sound level of a region is defined by the total acoustical energy being generated by known and unknown sources. These sources may include physical (*e.g.,* wind and waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic (*e.g.,* vessels, dredging, construction) sound. A number of sources contribute to ambient sound, including the following (Richardson *et al.,* 1995):

- *Wind and waves:* The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient sound for frequencies between 200 Hz and 50 kHz (Mitson, 1995). In general, ambient sound levels tend to increase with increasing wind speed and wave height. Surf sound becomes important near shore, with measurements collected at a distance of 8.5 km from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions.

• *Precipitation:* Sound from rain and hail impacting the water surface can become an important component of total sound at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times.

• *Biological:* Marine mammals can contribute significantly to ambient sound levels, as can some fish and snapping shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz.

• *Anthropogenic:* Sources of ambient sound related to human activity include transportation (surface vessels), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies. Vessel noise typically dominates the total ambient sound for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they attenuate rapidly. Sound from identifiable anthropogenic sources other than the activity of interest (*e.g.,* a passing vessel) is sometimes termed background sound, as opposed to ambient sound.

The sum of the various natural and anthropogenic sound sources at any given location and time—which comprise ‘‘ambient’’ or ‘‘background’’ sound—depends not only on the source levels (as determined by current weather conditions and levels of biological and human activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, ambient sound levels can be expected to vary widely over both coarse and fine spatial and temporal scales. Sound levels at a given frequency and location can vary by 10–20 dB from day to day (Richardson *et al.,* 1995). The result is that, depending on the source type and its intensity, sound from a given activity may be a negligible addition to the local environment or could form a distinctive signal that may affect marine mammals. Details of source types are described in the following text.

Sounds are often considered to fall into one of two general types: Pulsed and non-pulsed (defined in the following). The distinction between these two sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.* (2007) for an in-depth discussion of these concepts.

Pulsed sound sources (*e.g.,* airguns, explosions, gunshots, sonic booms, impact pile driving) produce signals that are brief (typically considered to be less than one second), broadband, atonal transients (ANSI, 1986, 2005; Harris, 1998; NIOSH, 1998; ISO, 2003) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a rapid decay period that may include a period of diminishing, oscillating maximal and minimal pressures, and generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulsed sounds can be tonal, narrowband, or broadband, brief or prolonged, and may be either continuous or non-continuous (ANSI, 1995; NIOSH, 1998). Some of these non-pulsed sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulsed sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (such as those used by the U.S. Navy). The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

The active acoustic sound sources proposed for use (*i.e.,* airgun arrays) produce pulsed signals. No other active acoustic systems are proposed for use for data acquisition purposes. Airguns produce sound with energy in a frequency range from about 10–2,000 Hz, with most energy radiated at frequencies below 200 Hz. The amplitude of the acoustic wave emitted from the source is equal in all directions (*i.e.,* omnidirectional), but airgun arrays do possess some directionality due to different phase delays between guns in different directions. Airgun arrays are typically tuned to maximize functionality for data acquisition purposes, meaning that sound transmitted in horizontal directions and at higher frequencies is minimized to the extent possible.

Vessel noise, produced largely by cavitation of propellers and by machinery inside the hull, is considered a non-pulsed sound. Sounds emitted by survey vessels are low frequency and continuous, but would be widely dispersed in both space and time. Survey vessel traffic is of very low density compared to commercial shipping traffic or commercial fishing vessels and would therefore be expected to represent an insignificant incremental increase in the total amount of anthropogenic sound input to the marine environment. We do not consider vessel noise further in this analysis.

Acoustic Effects

Here, we first provide background information on marine mammal hearing before discussing the potential effects of the use of active acoustic sources on marine mammals.

Marine Mammal Hearing—Hearing is the most important sensory modality for marine mammals underwater, and exposure to anthropogenic sound can have deleterious effects. To appropriately assess the potential effects of exposure to sound, it is necessary to understand the frequency ranges marine mammals are able to hear. Current data indicate that not all marine mammal species have equal hearing capabilities (*e.g.,* Richardson *et al.,* 1995; Wartzok and Ketten, 1999; Au and Hastings, 2008). To reflect this, Southall *et al.* (2007) recommended that marine mammals be divided into functional hearing groups based on directly measured or estimated hearing ranges on the basis of available behavioral response data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data. Note that no direct measurements of hearing ability have been successfully completed for mysticetes (*i.e.,* low-frequency cetaceans). Subsequently, NMFS (2016) described generalized hearing ranges for these marine mammal hearing groups. Generalized hearing ranges were chosen based on the approximately 65 dB threshold from the normalized composite audiograms, with the exception for lower limits for low-frequency cetaceans where the lower bound was deemed to be biologically implausible and the lower bound from Southall *et al.* (2007) retained. Pinniped functional hearing is not discussed here, as no pinnipeds are expected to be affected by the specified activity. The functional groups and the associated frequencies are indicated below (note that these frequency ranges correspond to the range for the composite group, with the entire range not necessarily reflecting the capabilities of every species within that group):

• Low-frequency cetaceans (mysticetes): Generalized hearing is estimated to occur between approximately 7 Hz and 35 kHz, with best hearing estimated to be from 100 Hz to 8 kHz;

- Mid-frequency cetaceans (larger toothed whales, beaked whales, and most delphinids): Generalized hearing is estimated to occur between approximately 150 Hz and 160 kHz, with best hearing from 10 to less than 100 kHz;
- High-frequency cetaceans (porpoises, river dolphins, and members of the genera *Kogia* and *Cephalorhynchus*; including two members of the genus *Lagenorhynchus,* on the basis of recent echolocation data and genetic data): Generalized hearing is estimated to occur between approximately 275 Hz and 160 kHz.

For more detail concerning these groups and associated frequency ranges, please see NMFS (2016) for a review of available information. Thirty-four marine mammal species, all cetaceans, have the reasonable potential to co-occur with the proposed survey activities. Please refer to Table 4. Of the species that may be present, seven are classified as low-frequency cetaceans (*i.e.,* all mysticete species), 24 are classified as mid-frequency cetaceans (*i.e.,* all delphinid and ziphiid species and the sperm whale), and three are classified as high-frequency cetaceans (*i.e.,* harbor porpoise and *Kogia* spp.).

Potential Effects of Underwater Sound—Please refer to the information given previously (''Description of Active Acoustic Sources'') regarding sound, characteristics of sound types, and metrics used in this document. Note that, in the following discussion, we refer in many cases to a recent review article concerning studies of noise-induced hearing loss conducted from 1996–2015 (*i.e.,* Finneran, 2015). For study-specific citations, please see that work. Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of highly variable impacts on marine life, from none or minor to potentially severe responses, depending on received levels, duration of exposure, behavioral context, and various other factors. The potential effects of underwater sound from active acoustic sources can potentially result in one or more of the following: Temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, stress, and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007; Götz *et al.,* 2009). The degree of effect is intrinsically related to the signal characteristics, received level, distance from the source, and duration of the sound exposure. In general, sudden, high level sounds can cause hearing loss, as can longer exposures to lower level sounds. Temporary or permanent loss of hearing will occur almost exclusively for noise within an animal's hearing range. We first describe specific manifestations of acoustic effects before providing discussion specific to the use of airgun arrays.

Richardson *et al.* (1995) described zones of increasing intensity of effect that might be expected to occur, in relation to distance from a source and assuming that the signal is within an animal's hearing range. First is the area within which the acoustic signal would be audible (potentially perceived) to the animal, but not strong enough to elicit any overt behavioral or physiological response. The next zone corresponds with the area where the signal is audible to the animal and of sufficient intensity to elicit behavioral or physiological responsiveness. Third is a zone within which, for signals of high intensity, the received level is sufficient to potentially cause discomfort or tissue damage to auditory or other systems. Overlaying these zones to a certain extent is the area within which masking (*i.e.,* when a sound interferes with or masks the ability of an animal to detect a signal of interest that is above the absolute hearing threshold) may occur; the masking zone may be highly variable in size.

We describe the more severe effects certain non-auditory physical or physiological effects only briefly as we do not expect that use of airgun arrays are reasonably likely to result in such effects (see below for further discussion). Potential effects from impulsive sound sources can range in severity from effects such as behavioral disturbance or tactile perception to physical discomfort, slight injury of the internal organs and the auditory system, or mortality (Yelverton *et al.,* 1973). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to high level underwater sound or as a secondary effect of extreme behavioral reactions (*e.g.,* change in dive profile as a result of an avoidance reaction) caused by exposure to sound include neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007; Zimmer and Tyack, 2007; Tal *et al.,* 2015). The survey activities considered here do not involve the use of devices such as explosives or mid-frequency tactical sonar that are associated with these types of effects.

When a live or dead marine mammal swims or floats onto shore and is incapable of returning to sea, the event is termed a ''stranding'' (16 U.S.C. 1421h(3)). Marine mammals are known to strand for a variety of reasons, such as infectious agents, biotoxicosis, starvation, fishery interaction, ship strike, unusual oceanographic or weather events, sound exposure, or combinations of these stressors sustained concurrently or in series (*e.g.,* Geraci *et al.,* 1999). However, the cause or causes of most strandings are unknown (*e.g.,* Best, 1982). Combinations of dissimilar stressors may combine to kill an animal or dramatically reduce its fitness, even though one exposure without the other would not be expected to produce the same outcome (*e.g.,* Sih *et al.,* 2004). For further description of specific stranding events see, *e.g.,* Southall *et al.,* 2006, 2013; Jepson *et al.,* 2013; Wright *et al.,* 2013.

Use of military tactical sonar has been implicated in a majority of investigated stranding events, although one stranding event was associated with the use of seismic airguns. This event occurred in the Gulf of California, coincident with seismic reflection profiling by the R/V *Maurice Ewing* operated by Columbia University's Lamont-Doherty Earth Observatory and involved two Cuvier's beaked whales (Hildebrand, 2004). The vessel had been firing an array of 20 airguns with a total volume of 8,500 in^3 (Hildebrand, 2004; Taylor *et al.,* 2004). Most known stranding events have involved beaked whales, though a small number have involved deep-diving delphinids or sperm whales (*e.g.,* Mazzariol *et al.,* 2010; Southall *et al.,* 2013). In general, long duration (~1 second) and high-intensity sounds (>235 dB SPL) have been implicated in stranding events (Hildebrand, 2004). With regard to beaked whales, mid-frequency sound is typically implicated (when causation can be determined) (Hildebrand, 2004). Although seismic airguns create predominantly low-frequency energy, the signal does include a mid-frequency component.

1. *Threshold Shift*—Marine mammals exposed to high-intensity sound, or to lower-intensity sound for prolonged periods, can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Finneran, 2015). TS can be permanent (PTS), in which case the loss of hearing sensitivity is not fully recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). Repeated sound

exposure that leads to TTS could cause PTS. In severe cases of PTS, there can be total or partial deafness, while in most cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985).

When PTS occurs, there is physical damage to the sound receptors in the ear (*i.e.,* tissue damage), whereas TTS represents primarily tissue fatigue and is reversible (Southall *et al.,* 2007). In addition, other investigators have suggested that TTS is within the normal bounds of physiological variability and tolerance and does not represent physical injury (*e.g.,* Ward, 1997). Therefore, NMFS does not consider TTS to constitute auditory injury.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is no PTS data for cetaceans, but such relationships are assumed to be similar to those in humans and other terrestrial mammals. PTS typically occurs at exposure levels at least several decibels above (a 40-dB threshold shift approximates PTS onset; *e.g.,* Kryter *et al.,* 1966; Miller, 1974) that inducing mild TTS (a 6-dB threshold shift approximates TTS onset; *e.g.,* Southall *et al.* 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS thresholds for impulse sounds (such as airgun pulses as received close to the source) are at least 6 dB higher than the TTS threshold on a peak-pressure basis and PTS cumulative sound exposure level thresholds are 15 to 20 dB higher than TTS cumulative sound exposure level thresholds (Southall *et al.,* 2007). Given the higher level of sound or longer exposure duration necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

For mid-frequency cetaceans in particular, potential protective mechanisms may help limit onset of TTS or prevent onset of PTS. Such mechanisms include dampening of hearing, auditory adaptation, or behavioral amelioration (*e.g.,* Nachtigall and Supin, 2013; Miller *et al.,* 2012; Finneran *et al.,* 2015; Popov *et al.,* 2016).

TTS is the mildest form of hearing impairment that can occur during exposure to sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be at a higher level in order to be heard. In terrestrial and marine mammals, TTS can last from minutes or hours to days (in cases of strong TTS). In many cases, hearing sensitivity recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals.

Marine mammal hearing plays a critical role in communication with conspecifics, and interpretation of environmental cues for purposes such as predator avoidance and prey capture. Depending on the degree (elevation of threshold in dB), duration (*i.e.,* recovery time), and frequency range of TTS, and the context in which it is experienced, TTS can have effects on marine mammals ranging from discountable to serious. For example, a marine mammal may be able to readily compensate for a brief, relatively small amount of TTS in a non-critical frequency range that occurs during a time where ambient noise is lower and there are not as many competing sounds present. Alternatively, a larger amount and longer duration of TTS sustained during time when communication is critical for successful mother/calf interactions could have more serious impacts.

Finneran et al. (2015) measured hearing thresholds in three captive bottlenose dolphins before and after exposure to ten pulses produced by a seismic airgun in order to study TTS induced after exposure to multiple pulses. Exposures began at relatively low levels and gradually increased over a period of several months, with the highest exposures at peak SPLs from 196 to 210 dB and cumulative (unweighted) SELs from 193–195 dB. No substantial TTS was observed. In addition, behavioral reactions were observed that indicated that animals can learn behaviors that effectively mitigate noise exposures (although exposure patterns must be learned, which is less likely in wild animals than for the captive animals considered in this study). The authors note that the failure to induce more significant auditory effects likely due to the intermittent nature of exposure, the relatively low peak pressure produced by the acoustic source, and the low-frequency energy in airgun pulses as compared with the frequency range of best sensitivity for dolphins and other mid-frequency cetaceans.

Currently, TTS data only exist for four species of cetaceans (bottlenose dolphin, beluga whale, harbor porpoise, and Yangtze finless porpoise (*Neophocoena asiaeorientalis*)) exposed to a limited number of sound sources (*i.e.,* mostly tones and octave-band noise) in laboratory settings (Finneran, 2015). In general, harbor porpoises have a lower TTS onset than other measured cetacean species (Finneran, 2015). Additionally, the existing marine mammal TTS data come from a limited number of individuals within these species. There are no data available on noise-induced hearing loss for mysticetes.

Critical questions remain regarding the rate of TTS growth and recovery after exposure to intermittent noise and the effects of single and multiple pulses. Data at present are also insufficient to construct generalized models for recovery and determine the time necessary to treat subsequent exposures as independent events. More information is needed on the relationship between auditory evoked potential and behavioral measures of TTS for various stimuli. For summaries of data on TTS in marine mammals or for further discussion of TTS onset thresholds, please see Southall *et al.* (2007), Finneran and Jenkins (2012), Finneran (2015), and NMFS (2016).

2. *Behavioral Effects*—Behavioral disturbance may include a variety of effects, including subtle changes in behavior (*e.g.,* minor or brief avoidance of an area or changes in vocalizations), more conspicuous changes in similar behavioral activities, and more sustained and/or potentially severe reactions, such as displacement from or abandonment of high-quality habitat. Behavioral responses to sound are highly variable and context-specific and any reactions depend on numerous intrinsic and extrinsic factors (*e.g.,* species, state of maturity, experience, current activity, reproductive state, auditory sensitivity, time of day), as well as the interplay between factors (*e.g.,* Richardson *et al.,* 1995; Wartzok *et al.,* 2003; Southall *et al.,* 2007; Weilgart, 2007; Archer *et al.,* 2010). Behavioral reactions can vary not only among individuals but also within an individual, depending on previous experience with a sound source, context, and numerous other factors (Ellison *et al.,* 2012), and can vary depending on characteristics associated with the sound source (*e.g.,* whether it is moving or stationary, number of sources, distance from the source). Please see Appendices B–C of Southall *et al.* (2007) for a review of studies involving marine mammal behavioral responses to sound.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. It is important to note that habituation is appropriately considered as a ''progressive reduction in response to stimuli that are perceived as neither aversive nor beneficial,'' rather than as, more generally, moderation in response to human disturbance (Bejder *et al.,* 2009). The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. As noted, behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003). Controlled experiments with captive marine mammals have showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; see also Richardson *et al.,* 1995; Nowacek *et al.,* 2007). However, many delphinids approach acoustic source vessels with no apparent discomfort or obvious behavioral change (*e.g.,* Barkaszi *et al.,* 2012).

Available studies show wide variation in response to underwater sound; therefore, it is difficult to predict specifically how any given sound in a particular instance might affect marine mammals perceiving the signal. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.,* Lusseau and Bejder, 2007; Weilgart, 2007; NRC, 2005). However, there are broad categories of potential response, which we describe in greater detail here, that include alteration of dive behavior, alteration of foraging behavior, effects to breathing, interference with or alteration of vocalization, avoidance, and flight.

Changes in dive behavior can vary widely, and may consist of increased or decreased dive times and surface intervals as well as changes in the rates of ascent and descent during a dive (*e.g.,* Frankel and Clark, 2000; Ng and Leung, 2003; Nowacek *et al.;* 2004; Goldbogen *et al.,* 2013a, b). Variations in dive behavior may reflect interruptions in biologically significant activities (*e.g.,* foraging) or they may be of little biological significance. The impact of an alteration to dive behavior resulting from an acoustic exposure depends on what the animal is doing at the time of the exposure and the type and magnitude of the response.

Disruption of feeding behavior can be difficult to correlate with anthropogenic sound exposure, so it is usually inferred by observed displacement from known foraging areas, the appearance of secondary indicators (*e.g.,* bubble nets or sediment plumes), or changes in dive behavior. As for other types of behavioral response, the frequency, duration, and temporal pattern of signal presentation, as well as differences in species sensitivity, are likely contributing factors to differences in response in any given circumstance (*e.g.,* Croll *et al.,* 2001; Nowacek *et al.;* 2004; Madsen *et al.,* 2006; Yazvenko *et al.,* 2007). A determination of whether foraging disruptions incur fitness consequences would require information on or estimates of the energetic requirements of the affected individuals and the relationship between prey availability, foraging effort and success, and the life history stage of the animal.

Visual tracking, passive acoustic monitoring, and movement recording tags were used to quantify sperm whale behavior prior to, during, and following exposure to airgun arrays at received levels in the range 140–160 dB at distances of 7–13 km, following a phase-in of sound intensity and full array exposures at 1–13 km (Madsen *et al.,* 2006; Miller *et al.,* 2009). Sperm whales did not exhibit horizontal avoidance behavior at the surface. However, foraging behavior may have been affected. The sperm whales exhibited 19 percent less vocal (buzz) rate during full exposure relative to post exposure, and the whale that was approached most closely had an extended resting period and did not resume foraging until the airguns had ceased firing. The remaining whales continued to execute foraging dives throughout exposure; however, swimming movements during foraging dives were 6 percent lower during exposure than control periods (Miller *et al.,* 2009). These data raise concerns that seismic surveys may impact foraging behavior in sperm whales, although more data are required to understand whether the differences were due to exposure or natural variation in sperm whale behavior (Miller *et al.,* 2009).

Variations in respiration naturally vary with different behaviors and alterations to breathing rate as a function of acoustic exposure can be expected to co-occur with other behavioral reactions, such as a flight response or an alteration in diving. However, respiration rates in and of themselves may be representative of annoyance or an acute stress response. Various studies have shown that respiration rates may either be unaffected or could increase, depending on the species and signal characteristics, again highlighting the importance in understanding species differences in the tolerance of underwater noise when determining the potential for impacts resulting from anthropogenic sound exposure (*e.g.,* Kastelein *et al.,* 2001, 2005, 2006; Gailey *et al.,* 2007; Gailey *et al.,* 2016).

Marine mammals vocalize for different purposes and across multiple modes, such as whistling, echolocation click production, calling, and singing. Changes in vocalization behavior in response to anthropogenic noise can occur for any of these modes and may result from a need to compete with an increase in background noise or may reflect increased vigilance or a startle response. For example, in the presence of potentially masking signals, humpback whales and killer whales have been observed to increase the length of their songs (Miller *et al.,* 2000; Fristrup *et al.,* 2003; Foote *et al.,* 2004), while right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks *et al.,* 2007). In some cases, animals may cease sound production during production of aversive signals (Bowles *et al.,* 1994).

Cerchio *et al.* (2014) used passive acoustic monitoring to document the presence of singing humpback whales off the coast of northern Angola and to opportunistically test for the effect of seismic survey activity on the number of singing whales. Two recording units were deployed between March and December 2008 in the offshore environment; numbers of singers were counted every hour. Generalized Additive Mixed Models were used to assess the effect of survey day (seasonality), hour (diel variation), moon phase, and received levels of noise (measured from a single pulse during each ten minute sampled period) on singer number. The number of singers significantly decreased with increasing received level of noise, suggesting that humpback whale breeding activity was disrupted to some extent by the survey activity.

Castellote *et al.* (2012) reported acoustic and behavioral changes by fin whales in response to shipping and airgun noise. Acoustic features of fin whale song notes recorded in the Mediterranean Sea and northeast

Atlantic Ocean were compared for areas with different shipping noise levels and traffic intensities and during a seismic airgun survey. During the first 72 h of the survey, a steady decrease in song received levels and bearings to singers indicated that whales moved away from the acoustic source and out of the study area. This displacement persisted for a time period well beyond the 10-day duration of seismic airgun activity, providing evidence that fin whales may avoid an area for an extended period in the presence of increased noise. The authors hypothesize that fin whale acoustic communication is modified to compensate for increased background noise and that a sensitization process may play a role in the observed temporary displacement.

Seismic pulses at average received levels of 131 dB re 1 μPa^2-s caused blue whales to increase call production (Di Iorio and Clark, 2010). In contrast, McDonald *et al.* (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the acoustic source vessel (estimated received level 143 dB pk-pk). Blackwell *et al.* (2013) found that bowhead whale call rates dropped significantly at onset of airgun use at sites with a median distance of 41–45 km from the survey. Blackwell *et al.* (2015) expanded this analysis to show that whales actually increased calling rates as soon as airgun signals were detectable before ultimately decreasing calling rates at higher received levels (*i.e.,* 10-minute cSEL of ~127 dB). Overall, these results suggest that bowhead whales may adjust their vocal output in an effort to compensate for noise before ceasing vocalization effort and ultimately deflecting from the acoustic source (Blackwell *et al.,* 2013, 2015). These studies demonstrate that even low levels of noise received far from the source can induce changes in vocalization and/or behavior for mysticetes.

Avoidance is the displacement of an individual from an area or migration path as a result of the presence of a sound or other stressors, and is one of the most obvious manifestations of disturbance in marine mammals (Richardson *et al.,* 1995). For example, gray whales are known to change direction—deflecting from customary migratory paths—in order to avoid noise from seismic surveys (Malme *et al.,* 1984). Humpback whales showed avoidance behavior in the presence of an active seismic array during observational studies and controlled exposure experiments in western Australia (McCauley *et al.,* 2000). Avoidance may be short-term, with animals returning to the area once the noise has ceased (*e.g.,* Bowles *et al.,* 1994; Goold, 1996; Stone *et al.,* 2000; Morton and Symonds, 2002; Gailey *et al.,* 2007). Longer-term displacement is possible, however, which may lead to changes in abundance or distribution patterns of the affected species in the affected region if habituation to the presence of the sound does not occur (*e.g.,* Bejder *et al.,* 2006; Teilmann *et al.,* 2006).

Forney *et al.* (2017) detail the potential effects of noise on marine mammal populations with high site fidelity, including displacement and auditory masking, noting that a lack of observed response does not imply absence of fitness costs and that apparent tolerance of disturbance may have population-level impacts that are less obvious and difficult to document. As we discuss in describing our proposed mitigation earlier in this document, avoidance of overlap between disturbing noise and areas and/or times of particular importance for sensitive species may be critical to avoiding population-level impacts and because, particularly for animals with high site fidelity, there may be a strong motivation to remain in the area despite negative impacts. Forney *et al.* (2017) state that, for these animals, remaining in a disturbed area may reflect a lack of alternatives rather than a lack of effects. Among other case studies, the authors discuss beaked whales off Cape Hatteras, noting the apparent importance of this area to the species and citing studies indicating long-term, year-round fidelity. This information leads the authors to conclude that failure to appropriately address potential effects in this particular area could lead to severe biological consequences for these beaked whales, in part because displacement may adversely affect foraging rates, reproduction, or health, while an overriding instinct to remain could lead to more severe acute effects (Forney *et al.,* 2017).

A flight response is a dramatic change in normal movement to a directed and rapid movement away from the perceived location of a sound source. The flight response differs from other avoidance responses in the intensity of the response (*e.g.,* directed movement, rate of travel). Relatively little information on flight responses of marine mammals to anthropogenic signals exist, although observations of flight responses to the presence of predators have occurred (Connor and Heithaus, 1996). The result of a flight response could range from brief, temporary exertion and displacement from the area where the signal provokes flight to, in extreme cases, marine mammal strandings (Evans and England, 2001). However, it should be noted that response to a perceived predator does not necessarily invoke flight (Ford and Reeves, 2008), and whether individuals are solitary or in groups may influence the response.

Behavioral disturbance can also impact marine mammals in more subtle ways. Increased vigilance may result in costs related to diversion of focus and attention (*i.e.,* when a response consists of increased vigilance, it may come at the cost of decreased attention to other critical behaviors such as foraging or resting). These effects have generally not been demonstrated for marine mammals, but studies involving fish and terrestrial animals have shown that increased vigilance may substantially reduce feeding rates (*e.g.,* Beauchamp and Livoreil, 1997; Fritz *et al.,* 2002; Purser and Radford, 2011). In addition, chronic disturbance can cause population declines through reduction of fitness (*e.g.,* decline in body condition) and subsequent reduction in reproductive success, survival, or both (*e.g.,* Harrington and Veitch, 1992; Daan *et al.,* 1996; Bradshaw *et al.,* 1998). However, Ridgway *et al.* (2006) reported that increased vigilance in bottlenose dolphins exposed to sound over a five-day period did not cause any sleep deprivation or stress effects.

Many animals perform vital functions, such as feeding, resting, traveling, and socializing, on a diel cycle (24-hour cycle). Disruption of such functions resulting from reactions to stressors such as sound exposure are more likely to be significant if they last more than one diel cycle or recur on subsequent days (Southall *et al.,* 2007). Consequently, a behavioral response lasting less than one day and not recurring on subsequent days is not considered particularly severe unless it could directly affect reproduction or survival (Southall *et al.,* 2007). Note that there is a difference between multi-day substantive behavioral reactions and multi-day anthropogenic activities. For example, just because an activity lasts for multiple days does not necessarily mean that individual animals are either exposed to activity-related stressors for multiple days or, further, exposed in a manner resulting in sustained multi-day substantive behavioral responses.

Stone (2015) reported data from at-sea observations during 1,196 seismic surveys from 1994 to 2010. When large arrays of airguns (considered to be 500 in^3 or more) were firing, lateral displacement, more localized avoidance, or other changes in behavior were evident for most odontocetes. However, significant responses to large arrays were found only for the minke whale and fin whale. Behavioral responses observed included changes in swimming or surfacing behavior, with indications that cetaceans remained near the water surface at these times. Cetaceans were recorded as feeding less often when large arrays were active. Behavioral observations of gray whales during a seismic survey monitored whale movements and respirations pre-, during and post-seismic survey (Gailey *et al.,* 2016). Behavioral state and water depth were the best 'natural' predictors of whale movements and respiration and, after considering natural variation, none of the response variables were significantly associated with seismic survey or vessel sounds.

3. *Stress Responses*—An animal's perception of a threat may be sufficient to trigger stress responses consisting of some combination of behavioral responses, autonomic nervous system responses, neuroendocrine responses, or immune responses (*e.g.,* Seyle, 1950; Moberg, 2000). In many cases, an animal's first and sometimes most economical (in terms of energetic costs) response is behavioral avoidance of the potential stressor. Autonomic nervous system responses to stress typically involve changes in heart rate, blood pressure, and gastrointestinal activity. These responses have a relatively short duration and may or may not have a significant long-term effect on an animal's fitness.

Neuroendocrine stress responses often involve the hypothalamus-pituitary-adrenal system. Virtually all neuroendocrine functions that are affected by stress—including immune competence, reproduction, metabolism, and behavior—are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction, altered metabolism, reduced immune competence, and behavioral disturbance (*e.g.,* Moberg, 1987; Blecha, 2000). Increases in the circulation of glucocorticoids are also equated with stress (Romano *et al.,* 2004).

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and ''distress'' is the cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose serious fitness consequences. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other functions. This state of distress will last until the animal replenishes its energetic reserves sufficiently to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses are well-studied through controlled experiments and for both laboratory and free-ranging animals (*e.g.,* Holberton *et al.,* 1996; Hood *et al.,* 1998; Jessop *et al.,* 2003; Krausman *et al.,* 2004; Lankford *et al.,* 2005). Stress responses due to exposure to anthropogenic sounds or other stressors and their effects on marine mammals have also been reviewed (Fair and Becker, 2000; Romano *et al.,* 2002b) and, more rarely, studied in wild populations (*e.g.,* Romano *et al.,* 2002a). For example, Rolland *et al.* (2012) found that noise reduction from reduced ship traffic in the Bay of Fundy was associated with decreased stress in North Atlantic right whales. These and other studies lead to a reasonable expectation that some marine mammals will experience physiological stress responses upon exposure to acoustic stressors and that it is possible that some of these would be classified as ''distress.'' In addition, any animal experiencing TTS would likely also experience stress responses (NRC, 2003).

4. *Auditory Masking*—Sound can disrupt behavior through masking, or interfering with, an animal's ability to detect, recognize, or discriminate between acoustic signals of interest (*e.g.,* those used for intraspecific communication and social interactions, prey detection, predator avoidance, navigation) (Richardson *et al.,* 1995; Erbe *et al.,* 2016). Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher intensity, and may occur whether the sound is natural (*e.g.,* snapping shrimp, wind, waves, precipitation) or anthropogenic (*e.g.,* shipping, sonar, seismic exploration) in origin. The ability of a noise source to mask biologically important sounds depends on the characteristics of both the noise source and the signal of interest (*e.g.,* signal-to-noise ratio, temporal variability, direction), in relation to each other and to an animal's hearing abilities (*e.g.,* sensitivity, frequency range, critical ratios, frequency discrimination, directional discrimination, age or TTS hearing loss), and existing ambient noise and propagation conditions.

Under certain circumstances, marine mammals experiencing significant masking could also be impaired from maximizing their performance fitness in survival and reproduction. Therefore, when the coincident (masking) sound is man-made, it may be considered harassment when disrupting or altering critical behaviors. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. For example, low-frequency signals may have less effect on high-frequency echolocation sounds produced by odontocetes but are more likely to affect detection of mysticete communication calls and other potentially important natural sounds such as those produced by surf and some prey species. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (*e.g.,* Clark *et al.,* 2009) and may result in energetic or other costs as animals change their vocalization behavior (*e.g.,* Miller *et al.,* 2000; Foote *et al.,* 2004; Parks *et al.,* 2007; Di Iorio and Clark, 2009; Holt *et al.,* 2009). Masking can be reduced in situations where the signal and noise come from different directions (Richardson *et al.,* 1995), through amplitude modulation of the signal, or through other compensatory behaviors (Houser and Moore, 2014). Masking can be tested directly in captive species (*e.g.,* Erbe, 2008), but in wild populations it must be either modeled or inferred from evidence of masking compensation. There are few studies addressing real-world masking sounds likely to be experienced by marine mammals in the wild (*e.g.,* Branstetter *et al.,* 2013).

Masking affects both senders and receivers of acoustic signals and can potentially have long-term chronic effects on marine mammals at the population level as well as at the individual level. Low-frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, with most of the increase from distant commercial shipping (Hildebrand, 2009). All anthropogenic sound sources, but especially chronic and lower-frequency signals (*e.g.,* from vessel traffic), contribute to elevated ambient sound levels, thus intensifying masking.

Ship Strike

Vessel collisions with marine mammals, or ship strikes, can result in death or serious injury of the animal. Wounds resulting from ship strike may include massive trauma, hemorrhaging, broken bones, or propeller lacerations (Knowlton and Kraus, 2001). An animal at the surface may be struck directly by a vessel, a surfacing animal may hit the bottom of a vessel, or an animal just below the surface may be cut by a vessel's propeller. Superficial strikes may not kill or result in the death of the animal. These interactions are typically associated with large whales (*e.g.,* fin whales), which are occasionally found draped across the bulbous bow of large commercial ships upon arrival in port. Although smaller cetaceans are more maneuverable in relation to large vessels than are large whales, they may also be susceptible to strike. The severity of injuries typically depends on the size and speed of the vessel, with the probability of death or serious injury increasing as vessel speed increases (Knowlton and Kraus, 2001; Laist *et al.,* 2001; Vanderlaan and Taggart, 2007; Conn and Silber, 2013). Impact forces increase with speed, as does the probability of a strike at a given distance (Silber *et al.,* 2010; Gende *et al.,* 2011).

Pace and Silber (2005) also found that the probability of death or serious injury increased rapidly with increasing vessel speed. Specifically, the predicted probability of serious injury or death increased from 45 to 75 percent as vessel speed increased from 10 to 14 kn, and exceeded 90 percent at 17 kn. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death through increased likelihood of collision by pulling whales toward the vessel (Clyne, 1999; Knowlton *et al.,* 1995). In a separate study, Vanderlaan and Taggart (2007) analyzed the probability of lethal mortality of large whales at a given speed, showing that the greatest rate of change in the probability of a lethal injury to a large whale as a function of vessel speed occurs between 8.6 and 15 kn. The chances of a lethal injury decline from approximately 80 percent at 15 kn to approximately 20 percent at 8.6 kn. At speeds below 11.8 kn, the chances of lethal injury drop below 50 percent, while the probability asymptotically increases toward one hundred percent above 15 kn.

In an effort to reduce the number and severity of strikes of the endangered North Atlantic right whale, NMFS implemented speed restrictions in 2008 (73 FR 60173; October 10, 2008). These restrictions require that vessels greater than or equal to 65 ft (19.8 m) in length travel at less than or equal to 10 kn near key port entrances and in certain areas of right whale aggregation along the U.S. eastern seaboard. Conn and Silber (2013) estimated that these restrictions reduced total ship strike mortality risk levels by 80 to 90 percent.

For vessels used in seismic survey activities, vessel speed while towing gear is typically only 4–5 kn. At these speeds, both the possibility of striking a marine mammal and the possibility of a strike resulting in serious injury or mortality are discountable. At average transit speed, the probability of serious injury or mortality resulting from a strike is less than 50 percent. However, the likelihood of a strike actually happening is again discountable. Ship strikes, as analyzed in the studies cited above, generally involve commercial shipping, which is much more common in both space and time than is geophysical survey activity. Jensen and Silber (2004) summarized ship strikes of large whales worldwide from 1975–2003 and found that most collisions occurred in the open ocean and involved large vessels (*e.g.,* commercial shipping). Commercial fishing vessels were responsible for three percent of recorded collisions, while no such incidents were reported for geophysical survey vessels during that time period.

It is possible for ship strikes to occur while traveling at slow speeds. For example, a hydrographic survey vessel traveling at low speed (5.5 kn) while conducting mapping surveys off the central California coast struck and killed a blue whale in 2009. The State of California determined that the whale had suddenly and unexpectedly surfaced beneath the hull, with the result that the propeller severed the whale's vertebrae, and that this was an unavoidable event. This strike represents the only such incident in approximately 540,000 hours of similar coastal mapping activity ($p = 1.9 \times 10^{-6}$; 95% CI = 0–5.5×10^{-6}; NMFS, 2013b). In addition, a research vessel reported a fatal strike in 2011 of a dolphin in the Atlantic, demonstrating that it is possible for strikes involving smaller cetaceans to occur. In that case, the incident report indicated that an animal apparently was struck by the vessel's propeller as it was intentionally swimming near the vessel. While indicative of the type of unusual events that cannot be ruled out, neither of these instances represents a circumstance that would be considered reasonably foreseeable or that would be considered preventable.

Although the likelihood of vessels associated with seismic surveys striking a marine mammal are low, we require a robust ship strike avoidance protocol (see ''Proposed Mitigation''), which we believe eliminates any foreseeable risk of ship strike. We anticipate that vessel collisions involving seismic data acquisition vessels towing gear, while not impossible, represent unlikely, unpredictable events for which there are no preventive measures. Given the required mitigation measures, the relatively slow speeds of vessels towing gear, the presence of bridge crew watching for obstacles at all times (including marine mammals), the presence of marine mammal observers, and the small number of seismic survey cruises, we believe that the possibility of ship strike is discountable and, further, that were a strike of a large whale to occur, it would be unlikely to result in serious injury or mortality. No incidental take resulting from ship strike is anticipated, and this potential effect of the specified activity will not be discussed further in the following analysis.

Other Potential Impacts—Here, we briefly address the potential risks due to entanglement and contaminant spills. We are not aware of any records of marine mammal entanglement in towed arrays such as those considered here. The discharge of trash and debris is prohibited (33 CFR 151.51–77) unless it is passed through a machine that breaks up solids such that they 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 may be accidentally lost overboard. However, U.S. Coast Guard and Environmental Protection Act 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. Any permits issued by BOEM would include guidance for the handling and disposal of marine trash and debris, similar to the Bureau of Safety and Environmental Enforcement's (BSEE) NTL 2012–G01 (''Marine Trash and Debris Awareness and Elimination'') (BSEE, 2012; BOEM, 2014b). There are no meaningful entanglement risks posed by the described activity, and entanglement risks are not discussed further in this document.

Marine mammals could be affected by accidentally spilled diesel fuel from a vessel associated with proposed survey activities. Quantities of 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) (*e.g.,* Geraci and St. Aubin, 1980, 1985, 1990). However, the likelihood of a fuel spill during any particular geophysical survey is considered to be remote, and the potential for impacts to marine mammals would depend greatly on the size and location of a spill and meteorological conditions at the time of the spill. Spilled fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. The rate at which the fuel spreads would be determined by the prevailing conditions such as temperature, water currents, tidal streams, and wind speeds. Lighter, volatile components of the fuel would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the fuel spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of fuel lost by this process (Scholz *et al.,* 1999). We do not anticipate potentially meaningful effects to marine mammals as a result of any contaminant spill resulting from the proposed survey activities, and contaminant spills are not discussed further in this document.

Anticipated Effects on Marine Mammal Habitat

Effects to Prey—Marine mammal prey varies by species, season, and location and, for some, is not well documented. Fish react to sounds which are especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005) identified several studies that suggest fish may relocate to avoid certain areas of sound energy. Additional studies have documented effects of pulsed sound on fish, although several are based on studies in support of construction projects (*e.g.,* Scholik and Yan, 2001, 2002; Popper and Hastings, 2009). Sound pulses at received levels of 160 dB may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Pearson *et al.,* 1992; Skalski *et al.,* 1992). SPLs of sufficient strength have been known to cause injury to fish and fish mortality. The most likely impact to fish from survey activities at the project area would be temporary avoidance of the area. The duration of fish avoidance of a given area after survey effort stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the short timeframe in which any given acoustic source vessel would be operating in any given area. However, adverse impacts may occur to a few species of fish which may still be present in the project area despite operating in a reduced work window in an attempt to avoid important fish spawning time periods.

Acoustic Habitat—Acoustic habitat is the soundscape—which encompasses all of the sound present in a particular location and time, as a whole—when considered from the perspective of the animals experiencing it. Animals produce sound for, or listen for sounds produced by, conspecifics (communication during feeding, mating, and other social activities), other animals (finding prey or avoiding predators), and the physical environment (finding suitable habitats, navigating). Together, sounds made by animals and the geophysical environment (*e.g.,* produced by earthquakes, lightning, wind, rain, waves) make up the natural contributions to the total acoustics of a place. These acoustic conditions, termed acoustic habitat, are one attribute of an animal's total habitat.

Soundscapes are also defined by, and acoustic habitat influenced by, the total contribution of anthropogenic sound. This may include incidental emissions from sources such as vessel traffic, or may be intentionally introduced to the marine environment for data acquisition purposes (as in the use of airgun arrays). Anthropogenic noise varies widely in its frequency content, duration, and loudness and these characteristics greatly influence the potential habitat-mediated effects to marine mammals (please see also the previous discussion on masking under ''Acoustic Effects''), which may range from local effects for brief periods of time to chronic effects over large areas and for long durations. Depending on the extent of effects to habitat, animals may alter their communications signals (thereby potentially expending additional energy) or miss acoustic cues (either conspecific or adventitious). For more detail on these concepts see, *e.g.,* Barber *et al.,* 2010; Pijanowski *et al.,* 2011; Francis and Barber, 2013; Lillis *et al.,* 2014.

Problems arising from a failure to detect cues are more likely to occur when noise stimuli are chronic and overlap with biologically relevant cues used for communication, orientation, and predator/prey detection (Francis and Barber, 2013). Although the signals emitted by seismic airgun arrays are generally low frequency, they would also likely be of short duration and transient in any given area due to the nature of these surveys. As described previously, exploratory surveys such as these cover a large area but would be transient rather than focused in a given location over time and therefore would not be considered chronic in any given location.

In summary, activities associated with the proposed action are not likely to have a permanent, adverse effect on any fish habitat or populations of fish species or on the quality of acoustic habitat. Thus, any impacts to marine mammal habitat are not expected to cause significant or long-term consequences for individual marine mammals or their populations.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, section 3(18) of the MMPA defines ''harassment'' as: ''. . . any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).''

Anticipated takes would primarily be by Level B harassment, as use of the acoustic source (*i.e.,* airgun array) has the potential to result in disruption of behavioral patterns for individual marine mammals. There is also some potential for auditory injury (Level A harassment) to result from use of the acoustic source, primarily for either high-frequency or low-frequency hearing specialists due to larger predicted auditory injury zones (on the basis of peak pressure and cumulative SEL, respectively). Auditory injury is unlikely to occur for most mid-frequency hearing specialists (*e.g.,* dolphins, sperm whale). The proposed mitigation and monitoring measures are expected to minimize the severity of such taking to the extent practicable. It is unlikely that lethal takes would occur even in the absence of the proposed mitigation and monitoring measures, and no such takes are anticipated or proposed for authorization.

Sound Thresholds

We have historically used generic acoustic thresholds (see Table 5) to determine when an activity that produces sound might result in impacts to a marine mammal such that a take by harassment might occur. These thresholds should be considered guidelines for estimating when harassment may occur (*i.e.,* when an animal is exposed to levels equal to or exceeding the relevant criterion) in specific contexts; however, useful contextual information that may inform our assessment of effects is typically lacking and we consider these thresholds as step functions. We are aware of suggestions regarding new criteria concerning behavioral disruption (*e.g.,* Nowacek *et al.,* 2015), but there is currently no scientific agreement on the matter. NMFS will consider potential changes to the historical criteria for behavioral harassment in the future.

TABLE 5—HISTORICAL ACOUSTIC EXPOSURE CRITERIA FOR IMPULSIVE SOURCES

Criterion	Definition	Threshold
Level A harassment	Injury (onset PTS—any level above that which is known to cause TTS).	180 dB rms (cetaceans).
Level B harassment	Behavioral disruption	160 dB rms (impulse sources).

However, NMFS has recently introduced new technical guidance for auditory injury (equating to Level A harassment under the MMPA); for more information, please visit *www.nmfs.noaa.gov/pr/acoustics/guidelines.htm* (NMFS, 2016). Historical threshold levels for auditory injury were developed in the late 1990s using the best information available at the time (*e.g.,* HESS, 1999). Since the adoption of these historical thresholds, our understanding of the effects of noise on marine mammal hearing has greatly advanced (*e.g.,* Southall *et al.,* 2007; Finneran, 2015). The new technical guidance identifies the received levels, or thresholds, above which individual marine mammals are predicted to experience changes in their hearing sensitivity for all underwater anthropogenic sound sources, reflects the best available science, and better predicts the potential for auditory injury than does NMFS's historical criteria. The technical guidance reflects the best available science on the potential for noise to affect auditory sensitivity by:

• Dividing sound sources into two groups (*i.e.,* impulsive and non-impulsive) based on their potential to affect hearing sensitivity;

• Choosing metrics that better address the impacts of noise on hearing sensitivity, *i.e.,* peak sound pressure level (peak SPL) (better reflects the physical properties of impulsive sound sources, to affect hearing sensitivity) and cumulative sound exposure level (cSEL) (accounts for not only level of exposure but also durations of exposure);

• Dividing marine mammals into hearing groups and developing auditory weighting functions based on the science supporting that not all marine mammals hear and use sound in the same manner.

NMFS's new technical guidance (NMFS, 2016) builds upon the foundation provided by Southall *et al.* (2007), while incorporating new information available since development of that work (*e.g.,* Finneran, 2015). Southall *et al.* (2007) recommended specific thresholds under the dual metric approach (*i.e.,* peak SPL and cumulative SEL) and that marine mammals be divided into functional hearing groups based on measured or estimated functional hearing ranges. The premise of the dual criteria approach is that, while there is no definitive answer to the question of which acoustic metric is most appropriate for assessing the potential for injury, both the received level and duration of received signals are important to an understanding of the potential for auditory injury. Therefore, peak SPL is used to define a pressure criterion above which auditory injury is predicted to occur, regardless of exposure duration (*i.e.,* any single exposure at or above this level is considered to cause auditory injury), and cSEL is used to account for the total energy received over the duration of sound exposure (*i.e.,* both received level and duration of exposure) (Southall *et al.,* 2007; NMFS, 2016). As a general principle, whichever criterion is exceeded first (*i.e.,* results in the largest isopleth) would be used as the effective injury criterion (*i.e.,* the more precautionary of the criteria). Note that cSEL acoustic threshold levels incorporate marine mammal auditory weighting functions, while peak pressure thresholds do not (*i.e.,* flat or unweighted). NMFS (2016) recommends 24 hours as a maximum accumulation period relative to cSEL thresholds. For further discussion of auditory weighting functions and their application, please see NMFS (2016). Table 6 displays thresholds provided by NMFS (2016).

TABLE 6—EXPOSURE CRITERIA FOR AUDITORY INJURY FOR IMPULSIVE SOURCES

Hearing group	Peak pressure [1] (dB)	Cumulative sound exposure level [2] (dB)
Low-frequency cetaceans	219	183
Mid-frequency cetaceans	230	185
High-frequency cetaceans	202	155

[1] Referenced to 1 μPa; unweighted within generalized hearing range.

[2] Referenced to 1 μPa²s; weighted according to appropriate auditory weighting function.

NMFS considers these updated thresholds and associated weighting functions to be the best available information for assessing whether exposure to specific activities is likely to result in changes in marine mammal hearing sensitivity. However, all applications were submitted and declared adequate and complete prior to finalization of the technical guidance, based on the best available information at the time. BOEM's PEIS (BOEM, 2014a) does provide information enabling a reasonable approximation of potential acoustic exposures relative to the ''Southall criteria.'' While the peer-reviewed criteria provided by Southall *et al.* (2007) differ from that described by NMFS (2016), they do function substantively as a reasonable precursor to the new technical guidance. We derived applicant specific exposure estimates for Level A harassment from BOEM's PEIS and then corrected these to reasonably account for NMFS's new technical guidance. This process is described below (see ''Level A Harassment'').

Sound Field Modeling

BOEM's PEIS (BOEM, 2014a) provides information related to estimation of the sound fields that would be generated by potential geophysical survey activity on the mid- and south Atlantic OCS. We provide a summary description of that modeling effort here; for more information, please see Appendix D of BOEM's PEIS (Zykov and Carr, 2014 in BOEM, 2014a). The acoustic modeling generated a three-dimensional acoustic propagation field as a function of source characteristics and physical properties of the ocean for later integration with marine mammal density information in an animal movement model to estimate potential acoustic exposures.

The authors selected 15 modeling sites throughout BOEM's Mid-Atlantic and South Atlantic OCS planning areas for use in modeling predicted sound fields resulting from use of the airgun array. The water depth at the sites varied from 30–5,400 m. Two types of bottom composition were considered: Sand and clay, their selection depending on the water depth at the source. Twelve possible sound speed profiles for the water column were used to cover the variation of the sound velocity distribution in the water with location and season. Twenty-one distinct propagation scenarios resulted from considering different sound speed profiles at some of the modeling sites. Two acoustic propagation models were employed to estimate the acoustic field radiated by the sound sources. A version of JASCO Applied Science's Marine Operations Noise Model (MONM), based on the Range-dependent Acoustic Model (RAM) parabolic-equations model, MONM–RAM, was used to estimate the SELs for low-frequency sources (below 2 kHz) such as an airgun array. For more information on sound propagation model types, please see, *e.g.,* Etter (2013). The model takes into account the geoacoustic properties of the sea bottom, vertical sound speed profile in the water column, range-dependent bathymetry, and the directivity of the source. The directional source levels for the airgun array was modeled using the Airgun Array Source Model (AASM) based on the specifications of the source such as the arrangement and volume of the guns, firing pressure, and depth below the sea surface. The modeled directional source levels were used as the input for the acoustic propagation model. For background information on major factors affecting underwater sound propagation, please see Zykov and Carr (2014).

The modeling used a 5,400 in^3 airgun array as a representative example. The array has dimensions of 16 x 15 m and consists of 18 air guns placed in three identical strings of six air guns each (please see Figure D–6 of Zykov and Carr (2014)). The volume of individual air guns ranges from 105–660 in^3. Firing pressure for all elements is 2,000 psi. The depth below the sea surface for the array was set at 6.5 m. Please see Table 1 for a comparison to the airgun arrays proposed for use by the applicant companies. Horizontal third-octave band directionality plots resulting from source modeling are shown in Figure D–8 of Zykov and Carr (2014).

As noted, the AASM was used to predict the directional source level (SL) of the airgun array. The MONM was then used to estimate the acoustic field at any range from the source. MONM–RAM was used to predict the directional transmission loss (TL) footprint from various source locations corresponding to the selected modeling sites. The received level (RL) at any 3D location away from the source is calculated by combining the SL and TL, both of which are direction dependent, using the fundamental relation $RL = SL - TL$. Acoustic TL and RL are a function of depth, range, bearing, and environmental properties of the propagation medium. The RLs estimated by MONM, like the SLs from which they are computed, are expressed in terms of the SEL metric over the duration of a single source pulse. Sound exposure level is expressed in units of dB re 1 $\mu Pa^2 \cdot s$. For the purposes of this study, the SEL results were converted to the rms SPL metric using a range dependent conversion coefficient.

The U.S. Naval Oceanographic Office's Generalized Digital Environmental Model database was used to extract sound velocity profiles for the mid- and south Atlantic in order to characterize the entire water body into a discreet number of specific propagation regions. The profiles were selected to reflect the variation of sea water properties at the different locations selected throughout the mid- and south Atlantic OCS as well as seasonal variation at the same location (*i.e.,* winter, spring, summer, fall). The profiles for each season were grouped into about 17 regions with similar propagation characteristics and representative profiles for each region were selected. Finally, the bottom characteristics for each of these 17 regions were examined to determine if any region needed to be divided to accommodate the influence of the various bottom types on that region's propagation. The result was 21 separate modeling regions that in sum captured the propagation for the entire area; therefore, taken in conjunction with the 15 applicable sites there were a total of 21 modeling scenarios applicable to the airgun array. These scenarios are detailed in Table D–21 in Zykov and Carr (2014). Each acoustic modeling scenario is characterized by a unique combination of parameters. The main variables in the environment configuration are the bathymetry and the sound velocity profile in the water column. The geoacoustic properties of the sea bottom are directly correlated with the water depth of the modeling site. Four depth regions were classified based on bathymetry: Shallow continental shelf (<60 m); continental shelf (60–150 m); continental slope (150–1,000 m); and deep ocean (>1,000 m). The modeling results show that the largest threshold radii are typically associated with sites in intermediate water depths (250 and 900 m). Low frequencies propagate relatively poorly in shallow water (*i.e.,* water depths on the same order as or less than the wavelength). At intermediate water depths, this stripping of low-frequency sound no longer occurs, and longer-range propagation can be enhanced by the channeling of sound caused by reflection from the surface and seafloor (depending on the nature of the sound speed profile and sediment type).

Table 7 shows scenario-specific modeling results for distances to the 160 dB level; results presented are for the 95 percent range to threshold. Given a regularly gridded spatial distribution of modeled RLs, the 95 percent range is defined as the radius of a circle that encompasses 95 percent of the grid points whose value is equal to or greater than the threshold value. This definition is meaningful in terms of potential impact to an animal because, regardless of the geometrical shape of the noise footprint for a given threshold level, it always provides a range beyond which no more than five percent of a uniformly distributed population would be exposed to sound at or above that level. The maximum range, which is simply the distance to the farthest occurrence of the threshold level, is the more conservative but may misrepresent the effective exposure zone. For example, there are cases where the volume ensonified to a specific level may not be continuous and small pockets of higher RLs may be found far outside the main ensonified volume (for example, because of convergence). If only the maximum range is presented, a false impression of the extent of the acoustic field can be given (Zykov and Carr, 2014).

TABLE 7—MODELING SCENARIOS AND SITE-SPECIFIC MODELED THRESHOLD RADII FROM BOEM'S PEIS

Scenario No.	Site No.[1]	Water depth (m)	Season	Bottom type	Threshold radii (m)[2]
1	1	5,390	Winter	Clay	4,969
2	2	2,560	Winter	Clay	5,184
3	3	880	Winter	Sand	8,104
4	4	249	Winter	Sand	8,725
5	5	288	Winter	Sand	8,896
6	1	5,390	Spring	Clay	4,989
7	6	3,200	Spring	Clay	5,026
8	3	880	Spring	Sand	8,056
9	7	251	Spring	Sand	8,593
10	8	249	Spring	Sand	8,615
11	1	5,390	Summer	Clay	4,973
12	6	3,200	Summer	Clay	5,013
13	3	880	Summer	Sand	8,095
14	9	275	Summer	Sand	9,122
15	10	4,300	Fall	Clay	5,121
16	11	3,010	Fall	Clay	5,098
17	12	4,890	Fall	Clay	4,959
18	13	3,580	Fall	Clay	5,069
19	3	880	Fall	Sand	8,083
20	14	100	Fall	Sand	8,531
21	15	51	Fall	Sand	8,384
Mean					6,838

Adapted from Tables D–21 and D–22 of Zykov and Carr (2014).
[1] Please see Figure D–35 of Zykov and Carr (2014) for site locations.
[2] Threshold radii to 160 dB (rms) SPL, 95 percent range.

We provide this description of the modeling performed for BOEM's PEIS as a general point of reference for the proposed surveys, and also because three of the applicant companies—TGS, CGG, and Western—directly use these results to inform their exposure modeling, rather than performing separate sound field modeling. As described by BOEM (2014a), the modeled array was selected to be representative of the large airgun arrays likely to be used by geophysical exploration companies in the mid- and south Atlantic OCS. Therefore, we use the BOEM (2014a) results as a reasonable proxy for those two companies (please see ''Detailed Description of Activities'' for further description of the acoustic sources proposed for use by these two companies). ION and Spectrum elected to perform separate sound field modeling efforts, and these are described below. For generally applicable conclusions, as summarized from Appendix A of ION's application, see below.

ION—ION provided information related to estimation of the sound fields that would be generated by their proposed geophysical survey activity on the mid- and south Atlantic OCS. We provide a summary description of that modeling effort here; for more information, please see Appendix A of ION's application (Li, 2014; referred to hereafter as Appendix A of ION's application). ION proposes to use a 36-element airgun array with a 6,420 in^3 total firing volume (please see ''Detailed Description of Activities'' for further description of ION's acoustic source). The modeling assumed that ION would operate from July to December. Sixteen representative sites were selected along survey track lines planned by ION for use in modeling predicted sound fields resulting from use of the airgun array (see Figure 2 in Appendix A of ION's application for site locations). Two acoustic propagation models were employed to estimate the acoustic field radiated by the sound sources. As was described above for BOEM's PEIS, the acoustic signature of the airgun array was predicted using AASM and MONM was used to calculate the sound propagation and acoustic field near each defined site. The modeling process follows generally that described previously for BOEM's PEIS. Key differences are the characteristics of the acoustic source (see Table 1), locations of the modeled sites, and the use of a restricted set of sound velocity profiles (*e.g.,* fall and winter). Table 8 shows site-specific modeling results for distances to the 160 dB level; results presented are for the 95 percent range to threshold.

TABLE 8—SITE-SPECIFIC MODELED THRESHOLD RADII FOR ION

Site No.[1]	Water depth (m)	Season	Threshold radii (m)[2]
1	45	Fall	4,740
		Winter	5,270
2	820	Fall	7,470
		Winter	7,490
3	1,000	Fall	7,530
		Winter	7,480

TABLE 8—SITE-SPECIFIC MODELED THRESHOLD RADII FOR ION—Continued

Site No.[1]	Water depth (m)	Season	Threshold radii (m)[2]
4	40	Fall	4,200
		Winter	5,220
5	650	Fall	7,270
		Winter	7,370
6	1,500	Fall	5,210
		Winter	5,250
7	2,600	Fall	5,420
		Winter	5,390
8	30	Fall	4,480
		Winter	4,770
9	700	Fall	8,210
		Winter	8,250
10	3,300	Fall	5,410
		Winter	5,380
11	4,200	Fall	5,390
		Winter	5,360
12	30	Fall	3,250
		Winter	4,860
13	140	Fall	6,470
		Winter	6,750
14	2,400	Fall	5,460
		Winter	5,450
17[3]	2,200	Fall	5,600
		Winter	5,570
18[3]	4,180	Fall	5,400
		Winter	5,380
Mean		Fall	5,383
		Winter	5,953
		Overall	5,836

Adapted from Tables 1 and 17 of Appendix A in ION's application.
[1] Please see Figure 2 of Appendix A in ION's application for site locations.
[2] Threshold radii to 160 dB (rms) SPL, 95 percent range.
[3] Results for sites 15 and 16 are not presented, as the sites are outside the proposed survey area.

Spectrum—Spectrum provided information related to estimation of the sound fields that would be generated by their proposed geophysical survey activity on the mid- and south Atlantic OCS. We provide a summary description of that modeling effort here; for more information, please see Appendix A of Spectrum's application (Frankel *et al.,* 2015; referred to hereafter as Appendix A of Spectrum's application). Spectrum plans to use a 32-element airgun array with a 4,920 in^3 total firing volume (please see ''Detailed Description of Activities'' for further description of Spectrum's acoustic source). Array characteristics were input into the GUNDALF model to calculate the source level and predict the array signature. The directivity pattern of the airgun array was calculated using the beamforming module in the CASS-GRAB acoustic propagation model. These models provided source input information for the range-dependent acoustic model (RAM), which was then used to predict acoustic propagation and estimate the resulting sound field. The RAM model creates frequency-specific, three-dimensional directivity patterns (sound field) based upon the size and location of each airgun in the array. As described previously, physical characteristics of the underwater environment (*e.g.,* sound velocity profile, bathymetry, substrate composition) are critical to understanding acoustic propagation; 16 modeling locations were selected that span the acoustic conditions of the proposed seismic survey area. ION and Spectrum used the same modeling locations (Table 8). In contrast to ION's approach, Spectrum elected to use sound velocity profiles for winter and spring and assumed that half of the survey would occur in winter and half in spring. Table 9 shows site-specific modeling results for distances to the 160 dB level; results presented are for the 95 percent range to threshold.

TABLE 9—SITE-SPECIFIC MODELED THRESHOLD RADII FOR SPECTRUM

Site No.[1]	Water depth (m)	Threshold radii (m)[2]
1	45	12,400
2	820	9,900
3	1,000	9,600
4	40	7,850
5	650	9,350
6	1,500	7,600
7	2,600	6,700
8	30	7,650
9	700	9,150
10	3,300	6,700
11	4,200	7,000
12	30	24,300
13	140	14,750
14	2,400	7,650
17[3]	2,200	8,600
18[3]	4,180	7,200
Mean		9,775

Adapted from Table 6 of Spectrum's application.
[1] Please see Figure 5 of Appendix A in Spectrum's application for site locations.
[2] Threshold radii to 160 dB (rms) SPL, 95 percent range.
[3] Results for sites 15 and 16 are not presented, as the sites are outside the proposed survey area.

Generally applicable conclusions were discussed in Appendix A of ION's application, and are summarized here.

At shallow water sites, the sound field at long distances is dominated by intermediate frequencies (*i.e.,* 100–500 Hz) and the sound field varies significantly with direction because of the correspondingly high directivity of the source at these frequencies. Lower frequency energy is more rapidly attenuated and so is not able to propagate to very long distances. In contrast, the long-range spectra at deeper-water sites contain more low-frequency energy, resulting in longer propagation distances, and the shape of the sound field is also more strongly influenced by the directionality of the airgun array at low frequencies (*i.e.,* tens of hertz). Differences across seasons and sites are generally not great due to similar sound velocity profiles (*e.g.,* dominant downward refraction for depths greater than approximately 100 m) and counter-balancing effects of depth versus substrate composition. Shallow-water sites have mostly sandy sediments, which are more acoustically reflective, but low frequencies (as are produced by airguns) propagate relatively poorly in shallow water. Deep-water sites are located over clay sediments, which are associated with greater bottom loss, but this is balanced by the better low-frequency propagation in deep water. The largest threshold radii are seen in intermediate depths, because these sites are located over acoustically reflective sand sediments but in depths at which low-frequency sound is no longer stripped out. Further, longer-range propagation at these sites can be increased by sound channeling due to reflection from the sea surface and seabed (depending on the sound velocity profiles and sediment types).

Marine Mammal Density Information

The best available scientific information was considered in conducting marine mammal exposure estimates (the basis for estimating take). Historically, distance sampling methodology (Buckland *et al.,* 2001) has been applied to visual line-transect survey data to estimate abundance within large geographic strata (*e.g.,* Fulling *et al.,* 2003; Mullin and Fulling, 2004; Palka, 2006). Design-based surveys that apply such sampling techniques produce stratified abundance estimates and do not provide information at appropriate spatiotemporal scales for assessing environmental risk of a planned survey. To address this issue of scale, efforts were developed to relate animal observations and environmental correlates such as sea surface temperature in order to develop predictive models used to produce fine-scale maps of habitat suitability (*e.g.,* Waring *et al.,* 2001; Hamazaki, 2002; Best *et al.,* 2012). However, these studies generally produce relative estimates that cannot be directly used to quantify potential exposures of marine mammals to sound, for example. A more recent approach known as density surface modeling, as seen in DoN (2007) and Roberts *et al.* (2016), couples traditional distance sampling with multivariate regression modeling to produce density maps predicted from fine-scale environmental covariates (*e.g.,* Becker *et al.,* 2014).

At the time the applications were initially developed, the best available information concerning marine mammal densities in the proposed survey area was the U.S. Navy's Navy Operating Area (OPAREA) Density Estimates (NODEs) (DoN, 2007). These habitat-based cetacean density models utilized vessel-based and aerial survey data collected by NMFS from 1998–2005 during broad-scale abundance studies. Modeling methodology is detailed in DoN (2007). A more advanced cetacean density modeling effort, described in Roberts *et al.* (2016), was ongoing during initial development of the applications, and the model outputs were made available to the applicant companies. All information relating to this effort was made publically available in March 2016.

The Roberts *et al.* (2016) modeling effort provided several key improvements with respect to the NODEs effort. While the NODEs effort utilized a robust collection of NMFS survey data, Roberts *et al.* (2016) expanded on this by incorporating additional aerial and shipboard survey data from NMFS and from other organizations collected over the period 1992–2014, ultimately incorporating 60 percent more shipboard and five hundred percent more aerial survey hours than did NODEs. In addition, Roberts *et al.* (2016) controlled for the influence of sea state, group size, availability bias, and perception bias on the probability of making a sighting, whereas NODEs controlled for none of these. There are multiple reasons why marine mammals may be undetected by observers. Animals are missed because they are underwater (availability bias) or because they are available to be seen, but are missed by observers (perception and detection biases) (*e.g.,* Marsh and Sinclair, 1989). Negative bias on perception or detection of an available animal may result from environmental conditions, limitations inherent to the observation platform, or observer ability. Therefore, failure to correct for these biases may lead to underestimates of cetacean abundance. Use of additional data was used to improve detection functions for taxa that were rarely sighted in specific survey platform configurations. The degree of underestimation would likely be particularly impactful for species that exhibit long dive times, such as sperm and beaked whales, or are hard for observers to detect, such as harbor porpoises. Roberts *et al.* (2016) modeled density from eight physiographic and 16 dynamic oceanographic and biological covariates, as compared with two dynamic environmental covariates considered in NODEs. In summary, consideration of additional survey data and an improved modeling strategy allowed for an increased number of taxa modeled and better spatiotemporal resolutions of the resulting predictions. In general, we consider the models produced by Roberts *et al.* (2016) to be the best available source of data regarding cetacean density in the Atlantic. More information, including the model results and supplementary information for each model, is available at *seamap.env.duke.edu/models/Duke-EC-GOM-2015/.*

Aerial and shipboard survey data produced by the Atlantic Marine Assessment Program for Protected Species (AMAPPS) program provides an additional source of information regarding marine mammal presence in the proposed survey areas. These surveys represent a collaborative effort between NMFS, BOEM, and the Navy. Although the cetacean density models described above do include survey data from 2010–14, the AMAPPS data was not made available to the model authors. Future model updates will incorporate these data, but as of this writing the AMAPPS data comprises a separate source of information (NMFS, 2010a, 2011, 2012, 2013a, 2014, 2015a).

Description of Exposure Estimates

Here, we provide applicant-specific descriptions of the processes employed to estimate potential exposures of marine mammals to given levels of received sound. The discussions provided here are specific to estimated exposures to NMFS criterion for Level B harassment (*i.e.,* 160 dB rms); we provide a separate discussion below regarding our process for estimating potential incidents of Level A harassment. We first describe the exposure modeling process performed for BOEM's PEIS as point of reference. Appendix E of the PEIS (BOEM, 2014a) provides full details.

This description builds on the description of sound field modeling provided earlier in this section and in

Appendix D of BOEM's PEIS. As described previously, 21 distinct acoustic propagation regions were defined. Reflecting seasonal differences in sound velocity profiles, these regions were specific to each season—there were five acoustic propagation regions in both winter and spring, four in summer, and seven propagation regions in fall (see Figures E–11 through E–14 in Appendix E of BOEM's PEIS). The seasonal distribution of marine mammals was examined using the NODEs database (DoN, 2007) to see if there was any additional correlation with the propagation regions. The seasonal distribution for each species was examined by overlaying the charts of the 21 acoustic modeling regions and the average density of each species was then numerically determined for each region. For each species modeled through the NODEs effort, the model outputs are four seasonal surface density plots (*e.g.,* Figure E–15 in Appendix E of BOEM's PEIS). However, the NODEs models do not provide outputs for the extended continental shelf areas seaward of the EEZ; therefore, known density information at the edge of the area modeled by NODEs was extrapolated to the remainder of the study area.

The results of the acoustic modeling exercise (*i.e.,* estimated 3D sound field) and the region-specific density estimates were then input into Marine Acoustics, Inc.'s Acoustic Integration Model (AIM). AIM is a software package developed to predict the exposure of receivers (*e.g.,* an animal) to any stimulus propagating through space and time through use of a four-dimensional, individual-based, Monte Carlo-based statistical model. Within the model, simulated marine animals (*i.e.,* animats) may be programmed to behave in specific ways on the basis of measured field data. An animat movement engine controls the geographic and vertical movements (*e.g.,* speed and direction) of sound sources and animats through four dimensions (time and space) according to user inputs. Species that normally inhabit specific environments can be constrained in the model to stay within that habitat (*e.g.,* deep-water species may be restricted from entering shallow waters where they would not be found).

Species-specific animats were created with programmed behavioral parameters describing dive depth, surfacing and dive durations, swimming speed, course change, and behavioral aversions (*e.g.,* water too shallow). The programmed animats were then randomly distributed over a given bounded simulation area; boundaries extend at least one degree of latitude or longitude beyond the extent of the vessel track to ensure an adequate number of animats in all directions, and to ensure that the simulation areas extend beyond the area where substantial behavioral reactions might be anticipated. Because the exact positions of sound sources and animals are not known in advance for proposed activities, multiple runs of realistic predictions are used to provide statistical validity to the simulated scenarios. Each species-specific simulation is seeded with a given density of animats; in this case, approximately 4,000 animats. In most cases, this represents a higher density of animats in the simulation (0.1 animats/km²) than occurs in the real environment. A separate simulation was created and run for each combination of location, movement pattern, and marine mammal species.

A model run consists of a user-specified number of steps forward in time, in which each animat is moved according to the rules describing its behavior. For each time step of the model run, the received sound levels at each animat (*i.e.,* each marine mammal) are calculated. AIM returns the movement patterns of the animats, and the received sound levels are calculated separately using the given acoustic propagation predictions at different locations. At the end of each time step, an animat ''evaluates'' its environment, including its 3D location, the time, and any received sound level, and may alter its course to react to the environment per any programmed aversions.

Animat positions relative to the acoustic source (*i.e.,* range, bearing, and depth) were used to extract received level estimates from the acoustic propagation modeling results. The source levels, and therefore subsequently the received levels, include the embedded corrections for signal pulse length and M-weighting. M-weighting is a type of frequency weighting curve intended to reflect the differential potential for sound to affect marine mammals based on their sensitivity to the particular frequencies produced (Southall *et al.,* 2007). Please see Appendix D of BOEM's PEIS for further description of the application of M-weighting filters. For each bearing, distance, and depth from the source, the received level values were expressed as SPLs (rms) with units of dB re 1µ Pa. These are then converted back to intensity and summed over the duration of the exercise to generate an integrated energy level, expressed in terms of dB re 1 µPa²-sec or dB SEL. The number of animats per species that exceeded a given criterion (*e.g.,* 160 dB rms; 198 dB cSEL) may then be determined, and these results scaled according to the relationship of model-to-real world densities per species. That is, the exposure results are corrected using the actual species- and region-specific density derived from the density model outputs to give real-world estimates of exposure to sound exceeding a given received level. In this case, the user-specified densities are typically at least an order of magnitude greater than the real-world densities to ensure a statistically valid result; therefore, the modeling result is corrected or scaled by the ratio of the actual density divided by the modeled density. Although there is substantial uncertainty associated with both the acoustic sound field estimation and animal movement modeling steps, confidence intervals were not developed for the exposure estimate results, in part because calculating confidence limits for numbers of Level B harassment takes would imply a level of quantification and statistical certainty that does not currently exist (BOEM, 2014a). Further detail regarding all aspects of the modeling process is provided in Appendix E of BOEM's PEIS.

As noted previously, the NODEs models (DoN, 2007) provided the best available information at the time of initial development for these applications. Outputs of the cetacean density models described by Roberts *et al.* (2016) were subsequently made available to the applicant companies. Two applicants (TGS and Western) elected to consider the new information and produced revised applications accordingly. CGG also used the new information in developing their application. Two applicants (Spectrum and ION) declined to use the Roberts *et al.* (2016) density models. However, because NMFS determined that the Roberts *et al.* (2016) density models represent the best available information (in relation to the NODEs models) we worked with Marine Acoustics, Inc.—which performed the initial exposure modeling provided in the Spectrum and ION applications—to produce revised exposure estimates utilizing the outputs of the Roberts *et al.* (2016) density models.

In order to revise the exposure estimates for Spectrum and ION, we first needed to extract appropriate density estimates from the Roberts *et al.* (2016) model outputs. Because both Spectrum and ION used modeling processes conceptually similar to that described above for BOEM's PEIS, these density estimates would replace those previously derived from the NODEs models in rescaling the exposure estimation results from those derived from animal movement modeling using a user-specified density. We summarize the steps involved in calculating mean marine mammal densities over the 21 modeling areas used in both BOEM's PEIS and the applications here:

- Roberts *et al.* (2016) predicted densities on an annual or monthly time period. When the time period was annual, we used the same density for all seasons. When the time period was monthly, we calculated the mean density for each season (using ArcGIS' cell statistics tool).
- We converted the Roberts *et al.* (2016) density units (animals/100 km^2) to animals/km^2.
- As was the case for the NODEs model outputs, the Roberts *et al.* (2016) model outputs are restricted to the U.S. EEZ. Although relevant information regarding cetacean densities in areas of the western North Atlantic beyond the EEZ was recently provided by Mannocci *et al.* (2017), this information was not available to the applicants in developing their applications and was not available to NMFS in preparing this document. Therefore, we similarly extended the edge densities to cover the area outside of the data extent. This was performed by converting the seasonal rasters to numeric Python arrays, then using Python array functions to extend the edge cells.
- With new density values covering the entire modeling extent, we then calculated the average density for each of the 21 modeling areas (using ArcGIS' Zonal Statistics as Table tool).

Spectrum—Spectrum's sound field estimation process was previously described, and their exposure modeling process is substantially similar to that described above for BOEM's PEIS. The exposure estimation results described in Spectrum's application are based on the NODEs models. Because the NODEs model outputs do not cover the full extent of the proposed survey area, density estimates from the eastern-most edge where data are known were extrapolated seaward to the spatial extent of the proposed survey area. The same acoustic propagation regions described for BOEM's PEIS were used by Spectrum for exposure modeling; however, Spectrum limited their analysis to winter and spring seasons and therefore used only ten of the 21 regions. Half of proposed survey activity was assumed to occur in winter and half in spring.

As was described for BOEM's PEIS, Spectrum used AIM to model animal movements within the estimated 3D sound field. However, Spectrum elected to seed the simulations with a lower animat density (0.05 animats/km^2) than was used for BOEM's PEIS modeling effort. Spectrum stated that the modeled animat density value was determined through a sensitivity analysis that examined the stability of the predicted exposure estimates as a function of animat density and that the modeled density was determined to accurately capture the full distributional range of probabilities of exposure for the proposed survey. Similar to the modeling performed for BOEM's PEIS, the source levels and therefore subsequently the received levels include the embedded corrections for M-weighting (Southall *et al.,* 2007).

AIM simulations consisted of 25 hours of survey track for each modeling site and animal group. This duration was selected to use a 24-hour sound energy accumulation period for exposure estimation. The first hour of model output is then discarded, as animal distributions will be unduly influenced by initial conditions. In addition, there was a difference between the amount of modeled survey trackline within each modeling region and the actual proposed amount of survey trackline. The potential impacts were scaled by the ratio of the total length of proposed trackline to the modeled length of trackline in each modeling region. Spectrum elected to program certain species' animats with one aversion; normally deep-water species were not allowed to move into waters shallower than 100 m. Avoidance of right whales as indicated by the time-area restrictions required by BOEM's ROD (BOEM, 2014b) was also accounted for.

Similar to modeling conducted for BOEM's PEIS, received sound level and 3D position of each animat were recorded to calculate exposure estimates at each time step. Thus unweighted SPL(rms) and SEL values, as well as M-weighted SEL values, were calculated and compared with their respective criteria. The SEL values at each time step were converted back to intensity and summed, to produce the 24-hr cSEL value for each individual animat. The numbers of animats with SPL(rms) and cSEL values that exceeded their respective regulatory criteria were considered exposed for that criteria.

Spectrum also included a mitigation simulation in their modeling process, *i.e.,* they attempted to quantify the effects that a shutdown for marine mammals occurring within a 500 m exclusion zone and subsequent 60 minute clearance period would have on exposure estimates. As was described for BOEM's PEIS, dataset outputs of the AIM simulation model contain an animat's received sound level (SEL or SPL), the distance between the source and the animat, and the depth of the animat. Spectrum used the distance value to determine if the animat was in the 500-m exclusion zone and the depth of the animat was used to determine if it was at or near the surface. If both of these conditions were true, then the animat was considered 'available' to be observed. However, an animal that is available to be observed may still be missed by an observer due to perception bias. Therefore, Spectrum attempted to model the probability that an animal available for observation would in fact be observed. A random number was generated and compared to the detection probability for the species being modeled (*P*(detect); detection probabilities are shown in Table 14 of Appendix A in Spectrum's application). If the random number was less than the *P*(detect) value then the animal was considered to have been detected; if greater, the animal was considered undetected. If an animat was detected, AIM would simulate the effect of the acoustic source being shut down by setting the received sound levels of all animats in the model run to zero for the next 60 minutes. Predicted exposures without this mitigation simulation were also presented (see Tables 15–16 in Appendix A of Spectrum's application for a comparison of the mitigation simulation effect).

In summary, the original exposure results were obtained using AIM to model source and animat movements, with received SEL for each animat predicted at a 30-second time step. This predicted SEL history was used to determine the maximum SPL (rms or peak) and cSEL for each animat, and the number of exposures exceeding relevant criteria recorded. The number of exposures are summed for all animats to get the number of exposures for each species, with that summed value then scaled by the ratio of real-world density to the model density value. The final scaling value was the ratio of the length of the modeled survey line and the length of proposed survey line in each modeling region. As described above, the exposure estimates provided in Spectrum's application were based on the NODEs model outputs. In order to make use of the best available information (*i.e.,* Roberts *et al.* (2016)), we extracted species- and region-specific density values as described above. These were provided to Marine Acoustics, Inc. in order to rescale the original exposure results produced using the seeded animat density; revised exposure estimates are shown in Table 10.

ION—ION's sound field estimation process was previously described, and their exposure modeling process is substantially similar to that described above for BOEM's PEIS (and for Spectrum). We do not repeat those descriptions in full but summarize some key elements and differences relating to ION's approach. Further detail may be found in Appendix B of ION's application.

The exposure estimation results described in ION's application are based on the NODEs models. The same acoustic propagation regions described for BOEM's PEIS were used by ION for exposure modeling; however, ION limited their analysis to summer and fall seasons and therefore used only 11 of the 21 regions. Whichever season returned the higher number of estimated exposures for a given species was assumed to be the season in which the survey occurred, *i.e.,* ION's requested take authorization corresponds to the higher of the two seasonal species-specific exposure estimates.

As was described for BOEM's PEIS, ION used AIM to model animal movements within the estimated 3D sound field. ION proposes to conduct survey effort along lines roughly parallel to and roughly perpendicular to the east coast. Because a number of these lines are similar to each other in terms of direction and location, a reduced number of modeling lines—five alongshore and five perpendicular to shore—were created to represent all of the proposed survey lines. The lines were then further broken into segments that correspond to the boundaries of the modeling regions (see Figure 4 in Appendix B of ION's application). Simulation durations varied depending on model line length. After models were run for each line segment and subsegment, the results from all segments in each of the survey areas were scaled to reflect the actual length of proposed survey lines and then combined. ION elected to seed the simulations with a variable animat density because of the variable length of the tracks and the varied habitat of some species. ION did not account for potential effectiveness of mitigation in their modeling effort.

In summary, the original exposure results were obtained using AIM to model source and animat movements, with received SEL for each animat predicted at a 30-second time step. This predicted SEL history was used to determine the maximum SPL (rms or peak) and cSEL for each animat, and the number of exposures exceeding relevant criteria recorded. The number of exposures are summed for all animats to get the number of exposures for each species, with that summed value then scaled by the ratio of real-world density to the model density value. The final scaling value was the ratio of the length of the modeled survey line and the length of proposed survey line in each modeling region. As described above, the exposure estimates provided in ION's application were based on the NODEs model outputs. In order to make use of the best available information (*i.e.,* Roberts *et al.* (2016)), we extracted species- and region-specific density values as described above. These were provided to Marine Acoustics, Inc. in order to rescale the original exposure results produced using the seeded animat density; revised exposure estimates are shown in Table 10.

TGS and Western—Because TGS and Western follow the same approach to estimating potential marine mammal exposures to underwater sound, we provide a single description. It is also important to note that both companies propose the use of a mitigation source (*i.e.,* 90 in^3 airgun) for line turns and transits not exceeding three hours and produced exposure estimates for such use of the source. As described previously in ''Proposed Mitigation,'' we do not propose to allow use of the mitigation source. Therefore, exposure estimates produced by both companies that account for proposed use of the source will be slightly overestimated. This applies only to the ten species whose exposure estimates are based on the Roberts *et al.* (2016) density models, as we were not presented with exposure estimates specific to the full-power array versus the mitigation source. The companies assumed that the sound field estimates provided by BOEM (2014a) would be applicable and consider three depth bins: <880 m, 880–2,560 m, >2,560 m. The 15 modeling sites have a notable depth discontinuity within the overall range (51–5,390 m), with no sites at depths between 880–2,560 m. When considering the 21 modeling scenarios across the 15 sites, threshold radii shown in Table 7 break down evenly with 11 at depths ≤880 m and ten at depths ≥2,560 m. The mean threshold radius for the scenarios at shallow sites is 8,473 m; for the scenarios at deep sites the average is 5,040 m. The overall mean for all scenarios is 6,838 m. Because there are no sites for depths between 880–2,560 m, we assume that the overall mean threshold distance is appropriate.

Because both applications were prepared by Smultea Environmental Sciences, LLC (SES) under contract to the applicant companies, in this section we refer hereafter to ''SES'' rather than to ''TGS and Western.'' SES considered both the Roberts *et al.* (2016) density models as well as the AMAPPS data (NMFS, 2010a, 2011, 2012, 2013a, 2014). In so doing, SES determined that there are aspects of the Roberts *et al.* (2016) methodology that limit the model outputs' applicability to estimating marine mammal exposures to underwater sound. In summary, SES described the following issues:

- There are very few sightings of some species despite substantial survey effort;
- The modeling approach extrapolates based on habitat associations and assumes some species' occurrence in areas where they have never been or were rarely documented (despite substantial effort);
- In some cases, uniform density models spread densities of species with small sample sizes across large areas of the EEZ without regard to habitat, and;
- The most recent NOAA shipboard and aerial survey data (*i.e.,* AMAPPS) were not included in model development.

In response to these general concerns regarding suitability of model outputs for exposure estimation, SES developed a scheme related to the number of observations in the dataset available to Roberts *et al.* (2016) for use in developing the density models. Extremely rare species (*i.e.,* less than four sightings in the proposed survey area) were considered to have a very low probability of encounter, and it was assumed that the species might be encountered once. Therefore, a single group of the species was considered as expected to be exposed to sound exceeding the 160 dB rms harassment criterion. We agree with this approach and further describe relevant information related to these species in subsequent sections below.

As described previously, marine mammal abundance has traditionally been estimated by applying distance sampling methodology (Buckland *et al.,* 2001) to visual line-transect survey data. Buckland *et al.* (2001) recommend a minimum sample size of 60–80 sightings to provide reasonably robust estimates of density and abundance to fit the mathematical detection function required for this estimation; smaller sample sizes result in higher variance and thus less confidence and less accurate estimates. For species meeting this guideline within the proposed survey area, SES used Roberts *et al.* (2016)'s model. For species with fewer sightings (but with greater than four sightings in the proposed survey area), SES used what they refer to as ''Line Transect Theory'' in conjunction with AMAPPS data to estimate species density within the assumed 160 dB rms zone of ensonification.

Ten species or species groups met SES' requirement of having at least 60 sightings within the proposed survey area in the dataset available to Roberts *et al.* (2016): Atlantic spotted dolphin, pilot whales, striped dolphin, beaked whales, bottlenose dolphin, Risso's dolphin, short-beaked common dolphin, sperm whale, humpback whale, and North Atlantic right whale. Roberts *et al.* (2016) were able to produce models at annual resolution for the first four species and at monthly resolution for the latter six. Because of proposed measures to avoid most impacts to the right whale, SES used monthly data only for May to October to estimate potential exposures. As an aside, we acknowledge that this approach is not correct. Rather than ignoring the months November–April, we believe the correct approach would be to use the results for those months, but only for the grid cells outside of the proposed closure areas. However, we do not believe that this is a meaningful error, as our proposed mitigation measures related to right whales (*i.e.,* avoidance of sound input into areas where right whales are expected to occur and an absolute shutdown requirement upon observation of any right whale at any distance) are anticipated to substantially avoid acute effects to right whales. SES summarizes the steps involved in this process as follows:

- Calculate area of ensonification to ≥160 dB (rms) around the operating acoustic source, including all track lines, run-outs, and ramp-ups/run-ins, assuming depth-specific isopleth distances described above. Overlapping areas were treated as if they did not overlap (*i.e.,* they were added together as separate polygon areas to account for multiple exposures in the same location), and were thus included in the total area used to estimate exposures.
- Calculate species-specific density estimates for each of the 10 km x 10 km grid cells used in the density models. For species with monthly resolution, an annual average was calculated, with the exception of the right whale which used the May–October average only.
- The density models' area of data coverage does not extend outside of the EEZ. As noted previously, although relevant information regarding cetacean densities in areas of the western North Atlantic beyond the EEZ was recently provided by Mannocci *et al.* (2017), this information was not available to SES in developing these applications. Therefore, available sighting data were used to evaluate whether a species had been observed offshore close to the EEZ; no specific distance was used because it was impossible to determine exact distances from the EEZ using available reports. For the humpback whale and right whale, available information indicated that the species would not be expected to occur outside the EEZ. For the remaining species, SES extrapolated density from the nearest neighbor grid cell. Assuming such uniform density swaths over long range outside the area of data coverage may overestimate potential exposures.
- For each 10 km x 10 km grid cell and for the areas of extrapolation outside the EEZ, SES then multiplied the estimated ensonified area by the appropriate density to produce estimates of exposure exceeding the 160 dB rms criterion.
- The projected ensonified area was mapped relative to right whale closure areas described by BOEM (2014b); therefore, this element of proposed mitigation was accounted for to a certain extent.

Seven species or species groups met SES' criterion for conducting exposure modeling, but did not have the recommended 60 sightings in the survey area: minke whale, fin whale, *Kogia* spp., harbor porpoise, pantropical spotted dolphin, clymene dolphin, and rough-toothed dolphin. For these species, SES did not feel use of the density models was appropriate and developed a method using the available data instead (*i.e.,* AMAPPS data as well as data considered by Roberts *et al.* (2016), excluding results of surveys conducted entirely outside of an area roughly coincident with the proposed survey area); species-specific rationale is provided in section 6.3 of either application. Please see section 6.3 of either application for further details regarding the AMAPPS survey effort considered by SES. Table 6–1 in either application summarizes the AMAPPS data available for consideration by the authors. Although Roberts *et al.* (2016) developed detection functions for these species by using proxies as necessary, SES suggests that the fact that sightings of these species are not common indicate the species are less common than the density models show. SES states further that, while use of the density models for these species may be appropriate for localized activities, using them over broad geographical scales ultimately grossly overestimates the likely exposures of these species. SES summarizes the steps involved in this process as follows (see Table 6–4 in either application for numerical process details):

- Calculate the transect area, specific to aerial and vessel surveys, that would be considered to include sightings of all animals present for each species based on effective strip widths (ESW; the distance at which missed sightings made inside the distance is equal to detected sightings outside of it) obtained from the literature. The transect area is equal to twice the ESW multiplied by the length of transect (see Table 6–3 in either application for ESW values and citations).
- Calculate the mean density (in groups/km^2) for each species for aerial and vessel surveys; multiply by mean group size to get an individual-based density estimate.
- Adjust the densities using a correction factor ($g(0)$) to account for animals missed due to observation biases. General $g(0)$ values for aerial and vessel surveys for each species from the literature were used (see Table 6–3 in either application for $g(0)$ values and citations). Densities for vessel-based and aerial surveys were then averaged for each species; proposed survey lines cover areas included in both aerial and vessel survey effort and this method accounts for high and low density areas across the survey.
- Calculate the number of animals of each species that would potentially occur within the previously determined 160-dB depth-specific radii and sum for an estimate of total incidents of exposure.

To be clear, we believe the density models described by Roberts *et al.* (2016) provide the best available information and recommend their use for species other than those expected to be extremely rare in a given area. However, SES used the most recent observational data available. We acknowledge their concerns regarding use of predictive density models for species with relatively few observations in the proposed survey area, *e.g.,* that model-derived density estimates must be applied cautiously on a species-by-species basis with the recognition that in some cases the out-of-bound predictions could produce unrealistic results (Becker *et al.,* 2014). Further, use of uniform (*i.e.,* stratified) density models assumes a given density over a large geographic range which may include areas where the species has rarely or never been observed. For the seven species or species groups that SES applied their alternative approach to, five are modeled in whole or part through use of stratified models. We also acknowledge (as do Roberts *et al.* (2016)) that predicted habitat may not be occupied at expected densities or that models may not agree in all cases with known occurrence patterns, and that there is uncertainty associated with predictive habitat modeling (*e.g.,* Becker *et al.,* 2010; Forney *et al.,* 2012). Overall, SES suggest that it is more appropriate in some circumstances to use less complex models requiring less knowledge of habitat preferences that do not risk overprediction of occurrence in areas that are suitable but for which there is no indication the species is common (or sometimes even present). We determined that their alternative approach (for seven species or species groups) is acceptable and provide further discussion. Importantly, we recognize that there is no model or approach that is always the most appropriate and that there may be multiple approaches that may be considered acceptable.

As described previously in this document, on July 29, 2015, we published a **Federal Register** notice inviting public review and comment on the applications we had received. In response to this opportunity to comment, J.J. Roberts and P.N. Halpin of Duke University's Marine Geospatial Ecology Lab submitted a public comment letter, which is available online with all other comments received at *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.* In part, Roberts and Halpin offered a critique of SES' methods and rationale while also commending their use of the AMAPPS data. We discussed the points raised by Roberts and Halpin with SES, which subsequently made certain corrections and prepared revised versions of the TGS and Western applications. M. Smultea and S. Courbis of SES submitted a letter (available on the same Web site) detailing their responses to these points. However, the use of an alternative methodology for the seven species is fundamentally the same and forms the basis for our proposed take authorization for those species (for TGS and Western).

Roberts and Halpin raised several key points (we also include any resolution in the bulleted points below):

- The Buckland *et al.* (2001) recommendation that sample size should generally be at least 60–80 should be considered as general guidance but not an absolute rule and, in fact, Buckland *et al.* (2001) provide no theoretical proof for it. Miller and Thomas (2015) provide an example where a detection function fitted to 30 sightings resulted in a detection function with low bias. NMFS's line-transect abundance estimates are in some cases based on many fewer sightings, *e.g.,* stock assessments based on Palka (2012). Roberts and Halpin also point out that SES used certain detection functions from Mullin and Fulling (2003), which were based on fewer than 60 observations. Please see the letters provided by Duke University and SES, respectively, for opposing points of view on this issue.
- SES does not correct for observation bias, resulting in underestimation of density. SES subsequently corrected this issue by using estimates of *g*(0) to correct for bias, as described above.
- SES used erroneous or inappropriate ESWs for several species, resulting in an overestimate of effective survey area and therefore an underestimate of density. SES subsequently incorporated additional ESW information and addressed these issues to the extent possible given the available data.
- Following on the first point described above, ESWs used by SES are based on less robust detection functions than those used by Roberts *et al.* (2016).
- SES did not take into account what is known about the habitat of the species it modeled using this method. For example, Roberts *et al.* (2016) appropriately assumed an on-shelf density of zero for *Kogia* spp., whereas SES derived a *Kogia* spp. density estimate by including on-shelf survey effort, where *Kogia* spp. would not be expected. SES countered that, for *Kogia* spp. in particular, the more recent AMAPPS data provides substantial new information regarding *Kogia* spp. due to the increased sightings in recent years and suggest that for exposure estimation exercises over broad scales such as these, it is less important where a species is encountered in relation to how many will be encountered.
- SES declined to use density models for certain species on the basis of a lack of observations within the proposed survey area, although the models are based on numerous observations overall. Roberts and Halpin state that, because the models incorporate substantial survey effort within the proposed survey area, they are well-informed with regard to the likelihood of species occurrence under relevant environmental conditions. However, this does not alter the fact that these species have only rarely been observed within the proposed survey area and, therefore, SES' contention that use of a predictive density model to estimate potential acoustic exposures is not the most appropriate method for some species.
- SES' combination of aerial and vessel-based densities is inappropriate, due to substantial biases in terms of distribution of survey effort, *i.e.,* aerial surveys occurred primarily on-shelf while vessel-based surveys mainly occurred off-shelf. Therefore, use of a simple mean can result in unknown bias for species with either oceanic or on-shelf distribution. Roberts and Halpin suggest combining density estimates by dividing survey transects into segments, estimating density separately for aerial and shipboard surveys, and producing a combined estimate that accounts for the area effectively surveyed by each. However, because the proposed surveys would occur both on and off the shelf, it does not seem that any potential bias would unduly influence the overall results obtained by SES.
- SES does not adequately consider available information (*i.e.,* acoustic monitoring results; Risch *et al.,* 2014) for the minke whale. However, while available acoustic monitoring data suggests seasonal presence of minke whales, it remains unclear in the absence of visual observations where the whales are in relation to the acoustic recorders and how many may be present.

CGG—CGG used applicable results from BOEM's sound field modeling exercise in conjunction with the outputs of models described by Roberts *et al.* (2016) to inform their estimates of likely acoustic exposures. Considering only the BOEM modeling sites that are in or near CGG's proposed survey area provided a mean radial distance to the 160 dB rms criterion of 6,751 m (range 5,013–8,593 m). CGG used ArcGIS (further detail regarding CGG's spatial analysis is provided as an appendix to CGG's application) to conduct an exposure analysis as described in their application and summarized as follows:

- A circle with a 6,751 m radius (representing the extent of the average expected 160 dB rms ensonification zone) was drawn around each trackline, effectively resulting in a survey track with 13,502 m total width. Taxon-specific model outputs, averaged over the six-month period planned for the survey (*i.e.,* July–December) where relevant, were uploaded into ArcGIS with the assumed ensonification zone to provide estimates of marine mammal exposures to noise above the 160 dB rms threshold.
- The Roberts *et al.* (2016) 100 km^2 grid cells—the spatial scale on which taxon-specific predicted abundance information is provided—were converted into a compatible format and then spatially referenced over the tracklines and associated areas of ensonification. The tracklines and associated areas of ensonification were populated with the cetacean density grids by calculating the difference between the pre- and post-extracted area.

• Roberts *et al.* (2016) did not provide predicted abundance information for areas beyond the EEZ. As noted previously, although relevant information regarding cetacean densities in areas of the western North Atlantic beyond the EEZ was recently provided by Mannocci *et al.* (2017), this information was not available to CGG in developing their application. Therefore, CGG performed an interpolation analysis to estimate density values for the approximately 11 percent of planned survey area outside the EEZ that was not included in Roberts *et al.* (2016).

Level A Harassment

As discussed earlier in this document, BOEM's PEIS (2014a) provides auditory injury exposure results on the basis of the Southall *et al.* (2007) guidance. In order to use the results provided by BOEM (2014a) in a way that adequately takes NMFS's technical acoustic guidance into consideration, we considered the total potential exposure of marine mammals to sound exceeding the relevant criterion and estimated such exposures that may occur as a result of each specific survey as a relative proportion of total line-km. We compiled predicted 2D seismic survey activity across all years considered in BOEM's PEIS (see Table E–11 of Appendix E in BOEM's PEIS), which yields a potential total of 616,174 line-km. We divided each company's proposed total trackline by this total before multiplying the total species-specific estimated exposures across years by this proportion to yield a total survey-specific estimate of potential Level A harassment on the basis of the Southall received energy criterion (for low-frequency cetaceans) and the 180-dB rms criterion (for mid- and high-frequency cetaceans) (see Tables Attachment E–4 and Attachment E–5 of Appendix E in BOEM's PEIS). Whether using the Southall guidance (Southall *et al.,* 2007) or NMFS's new technical guidance (NMFS, 2016) (*i.e.,* in consideration of both auditory weighting functions for cSEL and thresholds for both cSEL and peak pressure), accumulation of energy would be considered to be the predominant source of potential auditory injury for low-frequency cetaceans, while instantaneous exposure to peak pressure received levels would be considered to be the predominant source of injury for both mid- and high-frequency cetaceans. Although NMFS's historical 180-dB rms injury criterion is no longer reflective of the best available science, the exposure results provided in BOEM's PEIS relative to the criterion are the most appropriate for use in providing ''corrected'' estimates based on the relevant peak pressure thresholds. Use of these results provides a proxy for the highly uncertain risk of auditory injury due to any proposed survey, which we then adjusted to reasonably account for NMFS's new technical acoustic guidance.

For low-frequency cetaceans, in order to ''correct'' these estimates of potential Level A exposure to account for NMFS's new technical acoustic guidance, we followed the process outlined previously under ''Exclusion Zone and Shutdown Requirements.'' We obtained spectrum data (in 1 Hz bands) for a reasonably equivalent acoustic source in order to appropriately incorporate weighting functions (*i.e.,* those described in NMFS (2016) and Southall *et al.* (2007)) over the source's full acoustic band. Using these data, we made adjustments (dB) to the spectrum levels, by frequency, according to the weighting functions for each relevant hearing group. We then converted these adjusted/weighted spectrum levels to pressures (micropascals) in order to integrate them over the entire broadband spectrum, resulting in weighted source levels by hearing group. Using the safe distance methodology described by Sivle *et al.* (2014) with the hearing group-specific weighted source levels, and assuming spherical spreading propagation, source velocity of 4.5 kn, pulse duration of 100 milliseconds (ms), and applicant-specific shot intervals, we then calculated potential radial distances to auditory injury zones on the basis of the two separate sets of weighting functions and thresholds. Comparison of the predicted hearing group-specific areas ensonified above thresholds defined in Southall *et al.* (2007) and NMFS (2016) provided correction factors that we then applied to the exposure results calculated on the basis of the Southall *et al.* (2007) criteria. These ''corrected'' results are provided in Table 11.

For mid- and high-frequency cetaceans, we also calculated potential radial distances to auditory injury zones on the basis of the relevant peak pressure thresholds alone, assuming spherical spreading propagation (auditory weighting functions are not used in considering potential injury due to peak pressure received levels). Comparison of the predicted hearing group-specific areas ensonified above thresholds defined by the historical NMFS criterion (*i.e.,* 180-dB rms) and NMFS (2016) provided correction factors that we then applied to the BOEM PEIS exposure results calculated on the basis of the 180-dB rms criterion. These ''corrected'' results, which are more conservative than results for these two hearing groups calculated on the basis of the cSEL approach, are provided in Table 11.

We recognize that the Level A exposure estimates provided here are a rough approximation of actual exposures, for several reasons. First, specific trackline locations proposed by the applicant companies may differ somewhat from those considered in BOEM's PEIS. However, as noted above, BOEM's PEIS assumes a total of 616,174 line-km of 2D survey effort conducted over seven years. Therefore, it is likely that all portions of the proposed survey area are considered in the PEIS analysis. Second, the PEIS exposure estimates are based on outputs of the NODEs models (DoN, 2007) versus the density models described by Roberts *et al.* (2016), which we believe represent the best available information for purposes of exposure estimation. There are additional reasons why any estimate of exposures to levels of sound exceeding the Level A harassment criteria is likely an approximation: We do not have sufficient information to approximate the probability of marine mammal aversion and subsequent likelihood of Level A exposure and we do not generally incorporate the effects of mitigation on the likelihood of Level A exposure (though this is of less importance when considering the potential for Level A exposure due to cumulative exposure of sound energy). Our intention is to use the information available to us, in reflection of available science regarding the potential for auditory injury, to acknowledge the potential for such outcomes in a way that we think is a reasonable approximation.

We note here that four of the five applicant companies (excepting Spectrum) declined to request authorization of take by Level A harassment. Although ION's proposed survey is smaller in terms of survey line-km, their source is larger in terms of predicted acoustic output (see Table 1). TGS, CGG, and Western claim, in summary, that Level A exposures will not occur largely due to the effectiveness of proposed mitigation. We do not find this assertion credible and propose to authorize take by Level A harassment, as displayed in Table 11.

Rare Species

Certain species potentially present in the proposed survey areas are expected to be encountered only extremely rarely, if at all. Although Roberts *et al.* (2016) provide density models for these species (with the exception of the pygmy killer whale), due to the small numbers of sightings that underlie these models' predictions we believe it appropriate to account for the small likelihood that these species would be encountered by assuming that these species might be encountered once by a given survey, and that Level A harassment would not occur for these species. With the exception of the northern bottlenose whale, none of these species should be considered cryptic (*i.e.,* difficult to observe when present) versus rare (*i.e.,* not likely to be present). Average group size was determined by considering known sightings in the western North Atlantic (CETAP, 1982; Hansen *et al,* 1994; NMFS, 2010a, 2011, 2012, 2013a, 2014, 2015a; Waring *et al.,* 2007, 2015). It is important to note that our proposal to authorize take equating to harassment of one group of each of these species is not equivalent to expected exposure. We do not expect that these rarely occurring (in the proposed survey area) species will be exposed at all, but provide a precautionary authorization of take. We provide a brief description for each of these species.

Sei Whale—Very little is known of sei whales in the western North Atlantic outside of northern feeding grounds, and much of what is known of sei whale distribution and movements is based on whaling records (Prieto *et al.,* 2012). Spring is the period of greatest abundance in U.S. waters, but sightings are concentrated on feeding grounds in the Gulf of Maine and in the vicinity of Georges Bank, outside the proposed survey areas (CETAP, 1982; Hain *et al.,* 1985). There are no definitive sightings reported south of 40° N., *i.e.,* no sightings reported from the proposed survey areas, although NOAA surveys in 1992 and 1995 reported four ambiguous sightings of ''Bryde's or sei whales'' between Florida and Cape Hatteras in winter (Roberts *et al.,* 2015j). Additionally, passive acoustic monitoring has detected sei whales in the winter near Onslow Bay, North Carolina, and near the shelf break off of Jacksonville, Florida (*e.g.,* Read *et al.,* 2010, 2012; Frasier *et al.,* 2016; Debich *et al.,* 2013, 2014; Norris *et al.,* 2014), and one sei whale stranding is reported from North Carolina (Byrd *et al.,* 2014). It is worth noting that the model authors include the four ambiguous sightings in both the sei whale and Bryde's whale models, thereby potentially overestimating the density of one species or the other but acknowledging the potential presence of both species in the area (Roberts *et al.,* 2015j). Schilling *et al.* (1992) report a mean group size of 1.8 sei whales, similar to the average group size of 2.2 whales across all NMFS observations in the Atlantic. We assume an average group size of two whales.

Bryde's Whale—NMFS defines and manages a stock of Bryde's whales believed to be resident in the northern Gulf of Mexico, but does not define a separate stock in the western North Atlantic Ocean. Bryde's whales are occasionally reported off the southeastern U.S. and southern West Indies (Leatherwood and Reeves, 1983). Genetic analysis suggests that Bryde's whales from the northern Gulf of Mexico represent a unique evolutionary lineage distinct from other recognized Bryde's whale subspecies, including those found in the southern Caribbean and southwestern Atlantic off Brazil (Rosel and Wilcox, 2014). Two strandings from the southeastern U.S. Atlantic coast share the same genetic characteristics with those from the northern Gulf of Mexico but it is unclear whether these are extralimital strays or they indicate the population extends from the northeastern Gulf of Mexico to the Atlantic coast of the southern U.S. (Byrd *et al.,* 2014; Rosel and Wilcox, 2014). There are no definitive sightings of Bryde's whales from the U.S. Atlantic reported from surveys considered by Roberts *et al.* (2016), although, as noted above for the sei whale, NOAA surveys in 1992 and 1995 reported four ambiguous sightings of ''Bryde's or sei whales'' between Florida and Cape Hatteras in winter. These four ambiguous sightings provide the basis for a stratified density model (Roberts *et al.,* 2016). There are no NMFS observations of Bryde's whales outside the Gulf of Mexico, but Silber *et al.* (1994) reported an average group size of 1.2 whales from the Gulf of California. Given the similarities to sei whales, we assume an average group size of two whales.

Blue Whale—The blue whale is best considered as an occasional visitor in US Atlantic waters, which may represent the current southern limit of its feeding range (CETAP, 1982; Wenzel *et al.,* 1988). NMFS's minimum population abundance estimate is based on photo-identification of recognizable individuals in the Gulf of St. Lawrence (Waring *et al.,* 2010), and the few sightings in U.S. waters occurred in the vicinity of the Gulf of Maine. All sightings have occurred north of 40° N. (Roberts *et al.,* 2015e). However, blue whales have been detected acoustically in deep waters north of the West Indies and east of the U.S. EEZ (Clark, 1995). Roberts *et al.* (2016) produced a stratified density model on the basis of a few blue whale sightings in the vicinity of the Gulf of Maine (Roberts *et al.,* 2015e). Reports of blue whales in the eastern tropical Pacific and off of Australia are typically of lone whales or groups of two (Reilly and Thayer, 1990; Gill, 2002); NMFS sightings in the Atlantic are only of lone whales. Therefore, we assume an average group size of one whale.

Northern Bottlenose Whale—Northern bottlenose whales are considered extremely rare in U.S. Atlantic waters, with only five NMFS sightings. The southern extent of distribution is generally considered to be approximately Nova Scotia (though Mitchell and Kozicki (1975) reported stranding records as far south as Rhode Island), and there have been no sightings within the proposed survey areas. Whitehead and Wimmer (2005) estimated the size of the population on the Scotian Shelf at 163 whales (95 percent CI 119–214). Whitehead and Hooker (2012) report that northern bottlenose whales are found north of approximately 37.5° N. and prefer deep waters along the continental slope. Roberts *et al.* (2016) produced a stratified density model on the basis of four sightings in the vicinity of Georges Bank (Roberts *et al.,* 2015b). The five sightings in U.S. waters yield a mean group size of 2.2 whales, while MacLeod and D'Amico report a mean group size of 3.6 (n = 895). Here, we assume an average group size of four whales.

Killer Whale—Killer whales are also considered rare in U.S. Atlantic waters (Katona *et al.,* 1988; Forney and Wade, 2006), constituting 0.1 percent of marine mammal sightings in the 1978–81 Cetacean and Turtle Assessment Program surveys (CETAP, 1982). Roberts *et al.* (2016) produced a stratified density model on the basis of four killer whale sightings (Roberts *et al.,* 2015g), though Lawson and Stevens (2014) provide a minimum abundance estimate of 67 photo-identified individual killer whales. Available information suggests that survey encounters with killer whales would be unlikely but could occur anywhere within the proposed survey area and at any time of year (*e.g.,* Lawson and Stevens, 2014). Silber *et al.* (1994) reported observations of two and 15 killer whales in the Gulf of California (mean group size 8.5), while May-Collado *et al.* (2005) described mean group size of 3.6 whales off the Pacific coast of Costa Rica. Based on 12 CETAP sightings and one group observed during NOAA surveys (CETAP, 1982; NMFS, 2014), the average group size in the Atlantic is 6.8 whales. Therefore, we assume an average group size of seven whales.

False Killer Whale—Although records of false killer whales from the U.S. Atlantic are uncommon, a combination of sighting, stranding, and bycatch records indicates that this species does occur in the western North Atlantic (Waring *et al.,* 2015). Baird (2009) suggests that false killer whales may be naturally uncommon throughout their range. Roberts *et al.* (2016) produced a stratified density model on the basis of two false killer whale sightings (Roberts *et al.,* 2015m), and NMFS produced the first abundance estimate for false killer whales on the basis of one sighting during 2011 shipboard surveys (Waring *et al.,* 2015). Similar to the killer whale, we believe survey encounters would be unlikely but could occur anywhere within the proposed survey area and at any time of year. Mullin *et al.* (2004) reported a mean false killer whale group size of 27.5 from the Gulf of Mexico, and May-Collado *et al.* (2005) described mean group size of 36.2 whales off the Pacific coast of Costa Rica. The few sightings from CETAP (1982) and from NOAA shipboard surveys give an average group size of 10.3 whales. As a precaution, we will assume an average group size of 28 whales, as reported from the Gulf of Mexico.

Pygmy Killer Whale—The pygmy killer whale is distributed worldwide in tropical to sub-tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Jefferson *et al.* 1994; Waring *et al.,* 2007). Pygmy killer whales are rarely observed by NOAA surveys outside the Gulf of Mexico—one group was observed off of Cape Hatteras in 1992—and the rarity of such sightings may be due to a naturally low number of groups compared to other cetacean species (Waring *et al.,* 2007). NMFS has never produced an abundance estimate for this species and Roberts *et al.* (2016) were not able to produce a density model for the species. The 1992 sighting was of six whales; therefore, we assume an average group size of six.

Melon-headed Whale—Similar to the pygmy killer whale, the melon-headed whale is distributed worldwide in tropical to sub-tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Jefferson *et al.* 1994; Waring *et al.,* 2007). Melon-headed whales are rarely observed by NOAA surveys outside the Gulf of Mexico—groups were observed off of Cape Hatteras in 1999 and 2002—and the rarity of such sightings may be due to a naturally low number of groups compared to other cetacean species (Waring *et al.,* 2007). NMFS has never produced an abundance estimate for this species and Roberts *et al.* (2016) produced a stratified density model on the basis of four sightings (Roberts *et al.,* 2015d). The two sightings reported by Waring *et al.* (2007) yield an average group size of 50 whales.

Spinner Dolphin—Distribution of spinner dolphins in the Atlantic is poorly known, but they are thought to occur in deep water along most of the U.S. coast south to the West Indies and Venezuela (Waring *et al.,* 2014). There have been a handful of sightings in deeper waters off the northeast U.S. and one sighting during a 2011 NOAA shipboard survey off North Carolina, as well as stranding records from North Carolina south to Florida and Puerto Rico (Waring *et al.,* 2014). Roberts *et al.* (2016) provide a stratified density model on the basis of two sightings (Roberts *et al.,* 2015i). Regarding group size, Mullin *et al.* (2004) report a mean of 91.3 in the Gulf of Mexico; May-Collado (2005) describe a mean of 100.6 off the Pacific coast of Costa Rica; and CETAP (1982) sightings in the Atlantic yield a mean group size of 42.5 dolphins. As a precaution, we will assume an average group size of 91 dolphins, as reported from the Gulf of Mexico.

Fraser's Dolphin—As was stated for both the pygmy killer whale and melon-headed whale, the Fraser's dolphin is distributed worldwide in tropical waters, and is assumed to be part of the cetacean fauna of the tropical western North Atlantic (Perrin *et al.,* 1994; Waring *et al.,* 2007). The paucity of sightings of this species may be due to naturally low abundance compared to other cetacean species (Waring *et al.,* 2007). Despite possibly being more common in the Gulf of Mexico than in other parts of its range (Dolar, 2009), there were only five reported sightings during NOAA surveys from 1992–2009. In the Atlantic, NOAA surveys have yielded only two sightings (Roberts *et al.,* 2015f). May-Collado *et al.* (2005) reported a single observation of 158 Fraser's dolphins off the Pacific coast of Costa Rica, and Waring *et al.* (2007) describe a single observation of 250 Fraser's dolphins in the Atlantic, off Cape Hatteras. Therefore, we assume an average group size of 204 dolphins.

Atlantic White-sided Dolphin—White-sided dolphins are found in temperate and sub-polar continental shelf waters of the North Atlantic, primarily in the Gulf of Maine and north into Canadian waters (Waring *et al.,* 2016). Palka *et al.* (1997) suggest the existence of stocks in the Gulf of Maine, Gulf of St. Lawrence, and Labrador Sea. Stranding records from Virginia and North Carolina suggest a southerly winter range extent of approximately 35° N. (Waring *et al.,* 2016); therefore, it is possible that the proposed surveys could encounter white-sided dolphins. Roberts *et al.* (2016) elected to split their study area at the north wall of the Gulf Stream, separating the cold northern waters, representing probable habitat, from warm southern waters, where white-sided dolphins are likely not present (Roberts *et al.,* 2015k). Over 600 observations of Atlantic white-sided dolphins during CETAP (1982) and during NMFS surveys provide a mean group size estimate of 47.7 dolphins, while Weinrich *et al.* (2001) reported a mean group size of 52 dolphins. Here, we assume an average group size of 48 dolphins.

Table 10 displays the estimated incidents of potential exposures above given received levels of sound that are used to estimate Level B harassment, as derived by various methods described above. We do not include the 11 rarely occurring species described above, because our assumption that a single group of each species would be encountered does not constitute an exposure estimate (however they are considered in Table 11 for our proposed take authorizations). Total applicant-specific exposure estimates as a proportion of the most appropriate abundance estimate are presented. As described previously, for most species these estimated exposure levels apply to a generic western North Atlantic stock defined by NMFS for management purposes. For the humpback and sei whale, any takes are assumed to occur to individuals of the species occurring in the specific geographic region (which may or may not be individuals from the Gulf of Maine and Nova Scotia stocks, respectively). For bottlenose dolphins, NMFS defines an offshore stock and multiple coastal stocks of dolphins, and we are not able to quantitatively determine the extent to which the estimated exposures may accrue to the oceanic versus various coastal stocks. However, because of the spatial distribution of proposed survey effort and our proposed mitigation, we assume that almost all incidents of take for bottlenose dolphins would accrue to the offshore stock.

TABLE 10—ESTIMATED INCIDENTS OF POTENTIAL EXPOSURE FOR LEVEL B HARASSMENT

Common name	Abundance estimate	Spectrum		TGS		ION		Western		CGG	
		Level B	%	Level B	%	Level B	%	Level B	%	Level B	%
North Atlantic right whale	440	64	15	12	3	11	3	6	1	1	<1
Humpback whale	1,637	46	3	72	4	7	<1	49	3	7	<1
Minke whale	20,741	428	2	219	1	12	<1	103	<1	134	1
Fin whale	3,522	341	10	1,148	33	5	<1	538	15	50	1
Sperm whale	5,353	1,145	21	3,974	74	39	1	2,001	37	1,406	26
Kogia spp	3,785	211	6	1,232	33	31	1	577	15	249	7
Beaked whales	14,491	3,497	24	13,423	93	516	4	5,095	35	3,722	26
Rough-toothed dolphin	532	206	39	270	52	13	2	127	24	183	34
Common bottlenose dolphin	97,476	38,091	39	45,041	46	2,646	3	23,849	24	9,276	10
Clymene dolphin	12,515	6,613	53	1,102	9	273	2	517	4	6,609	53
Atlantic spotted dolphin	55,436	17,421	31	45,594	82	639	1	19,063	34	6,880	12
Pantropical spotted dolphin	4,436	1,671	38	1,542	35	84	2	723	16	1,623	37
Striped dolphin	75,657	8,339	11	26,136	35	233	<1	9,191	12	6,722	9
Short-beaked common dolphin	173,486	11,312	7	57,793	33	428	<1	20,936	12	6,220	4
Risso's dolphin	7,732	772	10	3,563	46	95	1	1,627	21	831	11
Globicephala spp	18,977	2,841	15	9,834	52	217	1	4,766	25	2,043	11
Harbor porpoise	45,089	637	1	334	1	21	<1	157	<1	32	<1

''Abundance estimate'' reflects what we believe is the most appropriate abundance estimate against which to compare each applicant's estimated exposures exceeding the 160 dB rms criterion. ''%'' represents predicted exposures exceeding the Level B harassment criterion as a percentage of abundance. We do not include predicted Level A exposures because these incidents are also included as Level B exposures and inclusion of these numbers would result in double-counting.

Table 11 provides the numbers of take by Level A and Level B harassment proposed for authorization. The proposed take authorizations combine the exposure estimates displayed in Table 10, estimated potential incidents of Level A harassment derived as described above, and the average group size information discussed previously in this section for sei whale, Bryde's whale, blue whale, northern bottlenose whale, Fraser's dolphin, melon-headed whale, false killer whale, pygmy killer whale, killer whale, spinner dolphin, and white-sided dolphin. For applicant- and species-specific proposed take authorizations marked by an asterisk, the predicted exposures (Table 10) have been reduced to 30 percent of the abundance estimate. The MMPA limits our ability to authorize take incidental to a specified activity to ''small numbers'' of marine mammals and, although this concept is not defined in the statute, NMFS interprets the concept in relative terms through comparison of the estimated number of individuals expected to be taken to an estimation of the relevant species or stock size. A relative approach to small numbers has been upheld in past litigation (see, *e.g.,* CBD v. Salazar, 695 F.3d 893 (9th Cir. 2012)). Here, we propose a take authorization limit of 30 percent of a stock abundance estimate. Although 30 percent is not a hard and fast cut-off, in cases such as this where exposure estimates constitute sizable percentages of the stock abundance and there are no qualitative factors to inform why the actual percentages are likely to be lower in fact, we believe it is appropriate to limit our proposed take authorizations to reasonably ensure the levels do not exceed ''small numbers.'' Proposed mechanisms to limit take to this amount are discussed further under ''Small Numbers Analyses'' and ''Proposed Monitoring and Reporting.''

TABLE 11—NUMBERS OF POTENTIAL INCIDENTAL TAKE PROPOSED FOR AUTHORIZATION

Common name	Spectrum		TGS		ION		Western		CGG	
	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B
North Atlantic right whale	0	64	0	12	0	11	0	6	0	[1]2
Humpback whale	16	46	22	72	12	7	2	49	22	7
Minke whale	0	428	1	219	0	12	0	103	1	134
Bryde's whale	0	2	0	2	0	2	0	2	0	2
Sei whale	0	2	0	2	0	2	0	2	0	2
Fin whale	0	341	0	*1,057	0	5	0	538	0	50
Blue whale	0	1	0	1	0	1	0	1	0	1
Sperm whale	5	1,145	4	*1,606	1	39	2	*1,606	1	1,406
Kogia spp	14	211	10	*1,136	3	31	5	577	4	249
Beaked whales	13	3,497	10	*4,347	0	516	5	*4,347	4	3,722
Northern bottlenose whale	0	4	0	4	0	4	0	4	0	4
Rough-toothed dolphin	0	*160	0	*160	0	[2]14	0	127	0	*160
Common bottlenose dolphin	210	*29,243	162	*29,243	44	2,646	84	23,849	62	9,276
Clymene dolphin	7	*3,755	5	1,102	1	273	3	517	2	*3,755
Atlantic spotted dolphin	102	*16,631	78	*16,631	21	639	41	*16,631	30	6,880
Pantropical spotted dolphin	15	*1,331	12	*1,331	3	84	6	723	4	*1,331
Spinner dolphin	0	91	0	91	0	91	0	91	0	91
Striped dolphin	67	8,339	52	*22,697	14	233	27	9,191	20	6,722
Short-beaked common dolphin	113	11,312	87	*52,046	24	428	45	20,936	33	6,220
Fraser's dolphin	0	204	0	204	0	204	0	204	0	204
Atlantic white-sided dolphin	0	48	0	48	0	48	0	48	0	48
Risso's dolphin	56	772	43	*2,320	12	95	22	1,627	17	831
Melon-headed whale	0	50	0	50	0	50	0	50	0	50
Pygmy killer whale	0	6	0	6	0	6	0	6	0	6
False killer whale	0	28	0	28	0	28	0	28	0	28
Killer whale	0	7	0	7	0	7	0	7	0	7
Pilot whales	94	2,841	72	*5,693	20	217	38	4,766	28	2,043

TABLE 11—NUMBERS OF POTENTIAL INCIDENTAL TAKE PROPOSED FOR AUTHORIZATION—Continued

Common name	Spectrum		TGS		ION		Western		CGG	
	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B	Level A	Level B
Harbor porpoise	6	637	4	334	1	21	2	157	2	32

* Proposed take authorization limited to 30 percent of best population abundance estimate.
[1] Increased from predicted exposure of one whale (Table 10) to account for assumed minimum group size (*e.g.,* Parks and Tyack, 2005).
[2] Exposure estimate (Table 10) increased by one to account for average group size observed during AMAPPS survey effort.

Analyses and Preliminary Determinations

Negligible Impact Analyses

NMFS has defined ''negligible impact'' in 50 CFR 216.103 as ''. . . an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.'' A negligible impact finding is based on the lack of likely adverse effects on annual rates of recruitment or survival (*i.e.,* population-level effects). An estimate of the number of takes alone is not enough information on which to base an impact determination. In addition to considering estimates of the number of marine mammals that might be ''taken'' through harassment, we consider other factors, such as the likely nature of any responses (*e.g.,* intensity, duration), the context of any responses (*e.g.,* critical reproductive time or location, migration), as well as effects on habitat. We also assess the number, intensity, and context of estimated takes by evaluating this information relative to population status. Consistent with the 1989 preamble for NMFS's implementing regulations (54 FR 40338; September 29, 1989), the impacts from other past and ongoing anthropogenic activities are incorporated into these analyses via their impacts on the environmental baseline (*e.g.,* as reflected in the regulatory status of the species, population size and growth rate where known, ongoing sources of human-caused mortality).

We first provide a generic description of our approach to the negligible impact analyses for this action, which incorporates elements of the impact assessment methodology described by Wood *et al.* (2012), before providing applicant-specific analysis. For each potential activity-related stressor, we consider the potential impacts on affected marine mammals and the likely significance of those impacts to the affected stock or population as a whole. Potential risk due to vessel collision and related mitigation measures as well as potential risk due to entanglement and contaminant spills were addressed under ''Proposed Mitigation'' and ''Potential Effects of the Specified Activity on Marine Mammals'' and are not discussed further, as there are minimal risks expected from these potential stressors.

Our analyses incorporate a simple matrix assessment approach to generate relative impact ratings that couple potential magnitude of effect on a stock and likely consequences of those effects for individuals, given biologically relevant information (*e.g.,* compensatory ability). Impact ratings are then combined with consideration of contextual information, such as the status of the stock or species, in conjunction with our proposed mitigation strategy, to ultimately inform our preliminary determinations. Figure 5 provides an overview of this framework. Elements of this approach are subjective and relative within the context of these particular actions and, overall, these analyses necessarily require the application of professional judgment.

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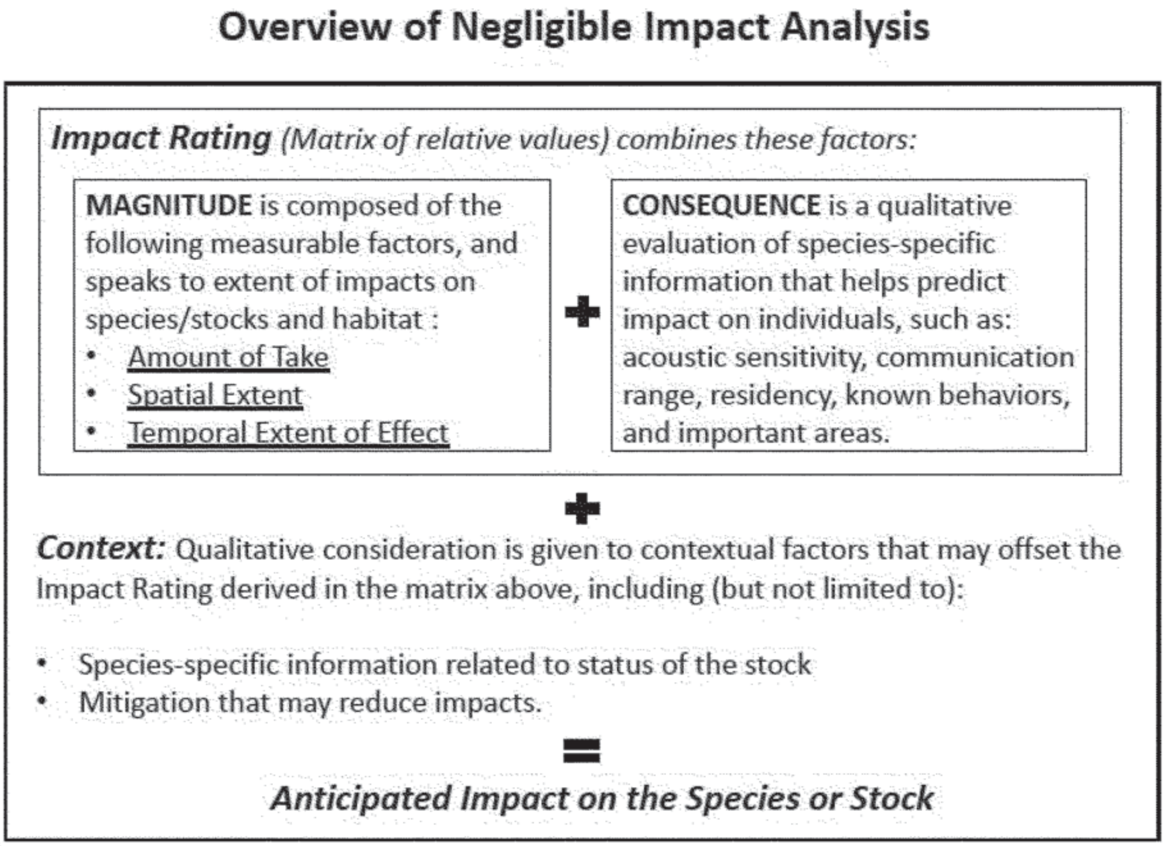

Figure 5. Overview of Negligible Impact Analysis Structure.

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Magnitude—We consider magnitude of effect as a semi-quantitative evaluation of measurable factors presented as relative ratings that address the extent of expected impacts to a species or stock and their habitat. Magnitude ratings are developed as a combination of measurable factors: The amount of take, the spatial extent of the effects in the context of the species range, and the duration of effects.

Amount of Take

We consider authorized Level B take less than five percent of population abundance to be de minimis, while authorized Level B taking between 5-15 percent is low. A moderate amount of authorized taking by Level B harassment would be from 15–25 percent, and high above 25 percent. Although we do not define quantitative metrics relating to amount of potential take by Level A harassment, for all applicant companies the expected potential for Level A harassment is expected to be low (Table 11).

Spatial Extent

Spatial extent relates to overlap of the expected range of the affected stock with the expected footprint of the stressor. While we do not define quantitative metrics relative to assessment of spatial extent, a relatively low impact would be a localized effect on the stock's range, a relatively moderate impact would be a regional-scale effect (meaning that the overlap between stressor and range was partial), and a relatively high impact would be one in which the degree of overlap between stressor and range is near total. For a mobile activity occurring over a relatively large, regional-scale area, this categorization is made largely on the basis of the stock range in relation to the action area. For example, the harbor porpoise is expected to occur almost entirely outside of the proposed survey areas (Waring *et al.,* 2016; Roberts *et al.,* 2016) and therefore despite the large extent of proposed survey activity, the spatial extent of potential stressor effect would be low. A medium degree of effect would be expected for a species such as the Risso's dolphin, which has a distribution in shelf and slope waters along the majority of the U.S. Atlantic coast, and which also would be expected to have greater abundance in mid-Atlantic waters north of the proposed survey areas in the summer (Waring *et al.,* 2016; Roberts *et al.,* 2016). This means that the extent of potential stressor for this species would at all times be expected to have some overlap with a portion of the stock, while some portion (increasing in summer and fall months) would at all times be outside the stressor footprint. A higher degree of impact with regard to spatial extent would be expected for a species such as the Clymene dolphin, which is expected to have a generally more southerly distribution (Waring *et al.,* 2016; Roberts *et al.,* 2016) and thus more nearly complete overlap with the expected stressor footprint in BOEM's Mid- and South Atlantic planning areas.

In Tables 14–18 below, spatial extent is presented as a range for certain species with known migratory patterns. We expect spatial extent (overlap of stock range with proposed survey area) to be low for right whales from May through October but moderate from November through April, due to right whale movements into southeastern shelf waters in the winter for calving. The overlap is considered moderate during winter because not all right whales make this winter migration, and those that do are largely found in shallow waters where little survey effort is planned. Spatial extent for humpback whales is expected to be low for most of the year, but likely moderate during winter, while spatial extent for minke whales is likely low in summer, moderate in spring and fall, and high in winter. While we consider spatial extent to be low year-round for fin whales, their range overlap with the proposed survey area does vary across the seasons and is closer to moderate in winter and spring. We expect spatial extent for common dolphins to be lower in fall but generally moderate. Similarly, we expect spatial extent for Risso's dolphins to be lower in summer but generally moderate. Although proposed survey plans differ across applicant companies, all cover large spatial scales that extend throughout much of BOEM's Mid- and South Atlantic OCS planning areas, and we do not expect meaningful differences across surveys with regard to spatial extent.

Temporal Extent

We consider a temporary effect lasting up to one month (prior to the animal or habitat reverting to a ''normal'' condition) to be short-term, whereas long-term effects are more permanent, lasting beyond one season (with animals or habitat potentially reverting to a ''normal'' condition). Moderate-term is therefore defined as between 1-3 months. Duration describes how long the effects of the stressor last. Temporal frequency may range from continuous to isolated (may occur one or two times), or may be intermittent. These metrics and their potential combinations help to derive the ratings summarized in Table 12. Temporal extent is not indicated in Tables 14–18 below, as it did not affect the magnitude rating for each applicant.

TABLE 12—MAGNITUDE RATING

Amount of take	Spatial extent	Duration and frequency	Magnitude rating
High	Any	Any	High.
Any except de minimis	High	Any.	
Moderate	Moderate	Any except short-term/isolated	
Moderate	Moderate	Short-term/isolated	Medium.
Moderate	Low	Any.	
Low	Moderate	Any.	
Low	Low	Any except short-term/intermittent or isolated	
Low	Low	Short-term/intermittent or isolated	Low.
De minimis	Any	Any	De minimis.

Adapted from Table 3.4 of Wood *et al.* (2012).

Likely Consequences—These considerations of amount, extent, and duration give an understanding of expected magnitude of effect for the stock or species and their habitat, which is then considered in context of the likely consequences of those effects for individuals. We consider likely relative consequences through a qualitative evaluation of species-specific information that helps predict the consequences of the known information addressed through the magnitude rating, *i.e.,* expected effects. This evaluation considers factors including acoustic sensitivity, communication range, known aspects of behavior relevant to a consideration of consequences of effects, and assumed compensatory abilities to engage in important behaviors (*e.g.,* breeding, foraging) in alternate areas. The magnitude rating and likely consequences are combined to produce an impact rating (Table 13).

For example, if a delphinid species is predicted to have a high amount of disturbance and over a high degree of spatial extent, that stock would receive a high magnitude rating for that particular proposed survey. However, we may then assess that the species may have a high degree of compensatory ability; therefore, our conclusion would be that the consequences of any effects are likely low. The overall impact rating in this scenario would be moderate. Table 13 summarizes impact rating scenarios.

TABLE 13—IMPACT RATING

Magnitude rating	Consequences (for individuals)	Impact rating
High	High/medium	High.
High	Low	Moderate.
Medium	High/medium	
Low	High	
Medium	Low	Low.
Low	Medium/low	
De minimis	Any	De minimis.

Adapted from Table 3.5 of Wood *et al.* (2012).

Likely consequences, as presented in Tables 14–18 below, are considered medium for each species of mysticete whales with greater than a de minimis amount of exposure, due to the greater potential that survey noise may subject individuals of these species to masking of acoustic space for social purposes (*i.e.,* they are low frequency hearing specialists). Likely consequences are considered medium for sperm whales due to potential for survey noise to disrupt foraging activity. The likely consequences are considered high for beaked whales due to the combination of known acoustic sensitivity and expected residency patterns, as we expect that compensatory ability for beaked whales will be low due to presumed residency in certain shelf break and deepwater canyon areas covered by the proposed survey area. Similarly, *Kogia* spp. are presumed to be a more acoustically sensitive species, but unlike beaked whales we expect that *Kogia* spp. would have a reasonable compensatory ability to perform important behavior in alternate areas, as they are expected to occur broadly over the continental slope (*e.g.,* Bloodworth and Odell, 2008)—therefore, we assume that consequences would be low for *Kogia* spp. generally. Consequences are considered low for most delphinids, as it is unlikely that disturbance due to survey noise would entail significant disruption of normal behavioral patterns, long-term displacement, or significant potential for masking of acoustic space. However, for pilot whales we believe likely consequences to be medium due to expected residency in areas of importance and, therefore, lack of compensatory ability. Because the nature of the stressor is the same across applicant companies, we do not expect meaningful differences with regard to likely consequences.

Context—In addition to impact ratings, we then also consider additional relevant contextual factors in a qualitative fashion. This consideration of context is applied to a given impact rating in order to produce a final assessment of impact to the stock or species, *i.e.,* our preliminary negligible impact determinations. Relevant contextual factors include population status, other stressors, and proposed mitigation.

Here, we reiterate discussion relating to our development of targeted mitigation measures and note certain contextual factors, which are applicable to negligible impact analyses for all five applicant companies. Applicant-specific analyses are provided later.

- We developed mitigation requirements (*i.e.,* time-area restrictions) designed specifically to provide benefit to certain species or stocks for which we predict a relatively moderate to high amount of exposure to survey noise and/or which have contextual factors that we believe necessitate special consideration. The proposed time-area restrictions, described in detail in ''Proposed Mitigation'' and depicted in Figures 3–4), are designed specifically to provide benefit to the North Atlantic right whale, bottlenose dolphin, sperm whale, beaked whales, pilot whales, and Atlantic spotted dolphin. In addition, we expect these areas to provide some subsidiary benefit to additional species that may be present. In particular, Area #5 (Figure 4), although delineated in order to specifically provide an area of anticipated benefit to beaked whales, sperm whales, and pilot whales, is expected to host a diverse assemblage of cetacean species. The output of the Roberts *et al.* (2016) models, as used in core abundance area analyses (described in detail in ''Proposed Mitigation''), indicates that species most likely to derive subsidiary benefit from this time-area restriction include the bottlenose dolphin (offshore stock), Risso's dolphin, and common dolphin. For species with density predicted through stratified models, core abundance analysis is not possible and assumptions regarding potential benefit of time-area restrictions are based on known ecology of the species and sightings patterns and are less robust. Nevertheless, subsidiary benefit for Areas #2–5 (Figure 4) should be expected for species known to be present in these areas (*e.g.,* assumed affinity for shelf/slope/abyss areas off Cape Hatteras): *Kogia* spp., pantropical spotted dolphin, Clymene dolphin, and rough-toothed dolphin.

These proposed measures benefit both the primary species for which they were designed and the species that may benefit secondarily by reducing the likely number of individuals exposed to survey noise and, for resident species in areas where seasonal closures are proposed, reducing the numbers of times that individuals are exposed to survey noise (also discussed in ''Small Numbers Analyses,'' below). However, and perhaps of greater importance, we expect that these restrictions will reduce disturbance of these species in the places most important to them for critical behaviors such as foraging and socialization. Area #2 (Figure 4), which is proposed as a year-round closure, is assumed to be an area important for beaked whale foraging, while Areas #3–4 (also proposed as year-round closures) are assumed to provide important foraging opportunities for sperm whales as well as beaked whales. Area #5, proposed as a seasonal closure, is comprised of shelf-edge habitat where beaked whales and pilot whales are believed to be year-round residents as well as slope and abyss habitat predicted to contain high abundance of sperm whales during the period of closure. Further detail regarding rationale for these closures is provided under ''Proposed Mitigation.''

- The North Atlantic right whale, sei whale, fin whale, blue whale, and sperm whale are listed as endangered under the Endangered Species Act, and all coastal stocks of bottlenose dolphin are designated as depleted under the MMPA (and have recently experienced an unusual mortality event, described earlier in this document). However, sei whales and blue whales are unlikely to be meaningfully impacted by the proposed activities (see ''Rare Species'' below). All four mysticete species are also classified as endangered (*i.e.,* ''considered to be facing a very high risk of extinction in the wild'') on the International Union for Conservation of Nature Red List of Threatened Species, whereas the sperm whale is classified as vulnerable (*i.e.,* ''considered to be facing a high risk of extinction in the wild'') (IUCN, 2016). Our proposed mitigation is designed to avoid impacts to the right whale and to depleted stocks of bottlenose dolphin. Survey activities must avoid all areas where the right whale and coastal stocks of bottlenose dolphin may be reasonably expected to occur, and we propose to require shutdown of the acoustic source upon observation of any right whale at any distance. If the observed right whale is within the behavioral harassment zone, it would still be considered to have experienced harassment, but by immediately shutting down the acoustic source the duration of harassment is minimized and the significance of the harassment event reduced as much as possible.

Although listed as endangered, the primary threat faced by the sperm whale (*i.e.,* commercial whaling) has been eliminated and, further, sperm whales in the western North Atlantic were little affected by modern whaling (Taylor *et al.,* 2008). Current potential threats to the species globally include vessel strikes, entanglement in fishing gear, anthropogenic noise, exposure to contaminants, climate change, and marine debris. However, for the North Atlantic stock, the most recent estimate of annual human-caused mortality and serious injury (M/SI) is just 22 percent of the potential biological removal (PBR) level for the stock. As described previously, PBR is defined as ''the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.'' For depleted stocks, levels of human-caused mortality and serious injury exceeding the PBR level are likely to delay restoration of the stock to OSP level by more than ten percent in comparison with recovery time in the absence of human-caused M/SI.

The most recent status review for the species stated that existing regulatory mechanisms appear to minimize threats to sperm whales and that, despite uncertainty regarding threats such as climate change, contaminants, and anthropogenic noise, the significance of threat facing the species should be considered low to moderate (NMFS, 2015b). Nevertheless, existing empirical data (*e.g.,* Miller *et al.,* 2009) highlight the potential for seismic survey activity to negatively impact foraging behavior of sperm whales. In consideration of this likelihood, the species status, and the relatively high amount of predicted exposures to survey noise, we have given special consideration to mitigation focused on sperm whales and have defined time-area restrictions (see ''Proposed Mitigation'' and Figure 4) specifically designed to reduce such impacts on sperm whales in areas expected to be of greatest importance (*i.e.,* slope habitat and deepwater canyons).

Although the primary direct threat to fin whales was addressed through the moratorium on commercial whaling, vessel strike and entanglement in commercial fishing gear remain as substantive direct threats for the species in the western North Atlantic. As noted below, the most recent estimate of annual average human-caused mortality for the fin whale in U.S. waters is above the PBR value (Table 4). In addition, the mysticete whales are particularly sensitive to sound in the frequency range output from use of airgun arrays (*e.g.,* NMFS, 2016). However, there is conflicting evidence regarding the degree to which this sound source may significantly disrupt the behavior of mysticete whales. Generally speaking, mysticete whales have been observed to react to seismic vessels but have also been observed continuing normal behavior in the presence of seismic vessels, and behavioral context at the time of acoustic exposure may be influential in the degree to which whales display significant behavioral reactions. In addition, while Edwards *et al.* (2015) found that fin whales were likely present in all seasons in U.S. waters north of 35° N., most important habitat areas are not expected to occur in the proposed survey areas. Primary feeding areas are outside the project area in the Gulf of Maine and off Long Island (LaBrecque *et al.,* 2015) and, while Hain *et al.* (1992) suggested that calving occurs during winter in the mid-Atlantic, Waring *et al.* (2016) state that it is unknown where calving, mating, and wintering occur for most of the population. Further, fin whales are not considered to engage in regular mass movements along well-defined migratory corridors (NMFS, 2010b). The model described by Roberts *et al.* (2016), which predicted density at a monthly time step, suggests an expectation that, while fin whales may be present year-round in shelf and slope waters north of Cape Hatteras, the large majority of predicted abundance in U.S. waters would be found outside the proposed survey areas to the north. Very few fin whales are likely present in the proposed survey areas in summer months. Therefore, we have determined that development of time-area restriction specific to fin whales is not warranted. However, fin whales present along the shelf break north of Cape Hatteras during the closure period associated with Area #5 (Figure 4) would be expected to benefit from the time-area restriction designed primarily to benefit pilot whales, beaked whales, and sperm whales.

• Critical habitat is designated only for the North Atlantic right whale, and there are no biologically important areas (BIA) described within the region (other than for the right whale, and the described BIA is similar to designated critical habitat). Our proposed mitigation is designed to minimize impacts to important habitat for the North Atlantic right whale.

• Average annual human-caused M/SI exceeds the PBR level for the North Atlantic right whale, sei whale, fin whale, and for both long-finned and short-finned pilot whales (see Table 4). Average annual M/SI is considered unknown for the blue whale and the false killer whale (PBR is undetermined for a number of other species (Table 4), but average annual human-caused M/SI is zero for all of these). Although threats are considered poorly known for North Atlantic blue whales, PBR is less than one and ship strike is a known cause of mortality for all mysticete whales. The most recent record of ship strike mortality for a blue whale in the U.S. EEZ is from 1998 (Waring *et al.,* 2010). False killer whales also have a low PBR value (2.1), and may be susceptible to mortality in commercial fisheries. One false killer whale was reported as entangled in the pelagic longline fishery in 2011, but was released alive and not seriously injured. Separately, a stranded false killer whale in 2009 was classified as due to a fishery interaction. Incidental take of the sei whale, blue whale, false killer whale, and long-finned pilot whale is considered unlikely and we propose to authorize take by behavioral harassment only for a single group of each of the first three species as a precaution. Although long-finned pilot whales are unlikely to occur in the action area in significant numbers, the density models that inform our exposure estimates consider pilot whales as a guild. It is important to note that our discussion of M/SI in relation to PBR values provides necessary contextual information related to the status of stocks; we do not equate harassment (as defined by the MMPA) with M/SI.

We addressed our consideration of specific mitigation efforts for the right whale and fin whale above. In response to this population context concern for pilot whales, in conjunction with relatively medium to high amount of predicted exposures to survey noise for pilot whales, we have given special consideration to mitigation focused on pilot whales and have defined time-area restrictions (see ''Proposed Mitigation'' and Figure 4) specifically designed to reduce such impacts on pilot whales in areas expected to be of greatest importance (*i.e.,* shelf edge north of Cape Hatteras).

• Beaked whales are considered to be particularly acoustically sensitive (*e.g.,* Tyack *et al.,* 2011; DeRuiter *et al.,* 2013; Stimpert *et al.,* 2014; Miller *et al.,* 2015). Considering this sensitivity in conjunction with the relatively high amount of predicted exposures to survey noise we have given special consideration to mitigation focused on beaked whales and have defined time-area restrictions (see ''Proposed Mitigation'' and Figure 4) specifically designed to reduce such impacts on beaked whales in areas expected to be of greatest importance (*i.e.,* shelf edge south of Cape Hatteras and deepwater canyon areas).

Rare Species—As described previously, there are multiple species that should be considered rare in the proposed survey areas and for which we propose to authorize only nominal and precautionary take of a single group. Specific to each of the five applicant companies, we do not expect meaningful impacts to these species (*i.e.,* sei whale, Bryde's whale, blue whale, killer whale, false killer whale, pygmy killer whale, melon-headed whale, northern bottlenose whale, spinner dolphin, Fraser's dolphin, Atlantic white-sided dolphin) and preliminarily find that the total marine mammal take from each of the specified activities will have a negligible impact on these marine mammal species. We do not discuss these 11 species further in these analyses.

Spectrum—Spectrum proposes a 165-day survey program, or 45 percent of the year (approximately two seasons). However, the proposed survey would cover a large spatial extent (*i.e.,* a majority of the mid- and south Atlantic; see Figure 1 of Spectrum's application). Therefore, although the survey would be long-term (*i.e.,* greater than one season) in total duration, we would not expect the duration of effect to be greater than moderate and intermittent in any given area. Table 14 displays relevant information leading to impact ratings for each species resulting from Spectrum's proposed survey. In general, we note that although the temporal and spatial scale of the proposed survey activity is large, the fact that this mobile acoustic source would be moving across large areas (as compared with geophysical surveys with different objectives that may require focused effort over long periods of time in smaller areas) means that many individuals may receive limited exposure to survey noise. The nature of such potentially transitory exposure (which we nevertheless assume here is of moderate duration and intermittent, versus isolated) means that the potential significance of behavioral disruption and potential for longer-term avoidance of important areas is limited.

TABLE 14—MAGNITUDE AND IMPACT RATINGS, SPECTRUM

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
North Atlantic right whale	Low	Low-Moderate	Medium	Medium	Moderate.
Humpback whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Minke whale	De minimis	Low-High	De minimis	n/a	De minimis.
Fin whale	Low	Low	Medium	Medium	Moderate.
Sperm whale	Moderate	Moderate	High	Medium	High.
Kogia spp	Low	High	High	Low	Moderate.
Beaked whales	Moderate	Moderate	High	High	High.
Rough-toothed dolphin	High	High	High	Low	Moderate.
Common bottlenose dolphin	High	High	High	Low	Moderate.
Clymene dolphin	High	High	High	Low	Moderate.
Atlantic spotted dolphin	High	Moderate	High	Low	Moderate.
Pantropical spotted dolphin	High	High	High	Low	Moderate.
Striped dolphin	Low	Low	Medium	Low	Low.
Short-beaked common dolphin	Low	Low-moderate	Medium	Low	Low.
Risso's dolphin	Low	Low-moderate	Medium	Low	Low.
Pilot whales	Low	Moderate	Medium	Medium	Moderate.
Harbor porpoise	De minimis	Low	De minimis	n/a	De minimis.

The North Atlantic right whale is endangered, has a very low population size, and faces significant additional stressors. Therefore, regardless of impact rating, we believe that the proposed mitigation described previously is important in order for us to make the necessary finding and, in consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on the North Atlantic right whale. The fin whale receives a moderate impact rating overall, but we expect that for two seasons (summer and fall) almost no fin whales will be present in the proposed survey area. For the remainder of the year, it is likely that less than one quarter of the population will be present within the proposed survey area (Roberts *et al.,* 2016), meaning that despite medium rankings for magnitude and likely consequences, these impacts would be experienced by only a small subset of the overall population. In consideration of the moderate impact rating, the likely proportion of the population that may be affected by the specified activities, and the lack of evidence that the proposed survey area is host to important behavior that may be disrupted, we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on the fin whale.

Magnitude ratings for the sperm whale and beaked whales are high and, further, consequence factors reinforce high impact ratings for both. Magnitude rating for pilot whales is medium but, similar to beaked whales, we expect that compensatory ability will be low due to presumed residency in areas targeted by the proposed survey—leading to a moderate impact rating. However, regardless of impact rating, the consideration of likely consequences and contextual factors leads us to conclude that targeted mitigation is important to support a finding that the effects of the proposed survey will have a negligible impact on these species. As described previously, sperm whales are an endangered species with particular susceptibility to disruption of foraging behavior, beaked whales are particularly acoustically sensitive (with presumed low compensatory ability), and pilot whales are sensitive to additional stressors due to a high degree of mortality in commercial fisheries (and also with low compensatory ability). Finally, due to their acoustic sensitivity, we have proposed shutdown of the acoustic source upon observation of a beaked whale at any distance from the source vessel. In consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on the sperm whale, beaked whales (*i.e., Ziphius cavirostris* and *Mesoplodon* spp.), and pilot whales (*i.e., Globicephala* spp.).

Kogia spp. receive a moderate impact rating. However, although NMFS does not currently identify a trend for these populations, recent survey effort and stranding data show a simultaneous increase in at-sea abundance and strandings, suggesting growing *Kogia* spp. abundance (NMFS, 2011; 2013a; Waring *et al.,* 2007; 2013). Finally, we expect that *Kogia* spp. will receive subsidiary benefit from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales and, although minimally effective due to the difficulty of at-sea observation of *Kogia* spp., we have proposed shutdown of the acoustic source upon observation of *Kogia* spp. at any distance from the source vessel. In consideration of these factors—likely population increase and proposed mitigation—we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on *Kogia* spp.

Despite medium to high magnitude ratings, remaining delphinid species receive low to moderate impact ratings due to a lack of propensity for behavioral disruption due to geophysical survey activity and our expectation that these species would generally have relatively high compensatory ability. In addition, these species do not have significant issues relating to population status or context. Many oceanic delphinid species are generally more associated with dynamic oceanographic characteristics rather than static physical features, and those species (such as common dolphin) with substantial distribution to the north of the proposed survey area would likely be little affected at the population level by the proposed activity. For example, both species of spotted dolphin and the offshore stock of bottlenose dolphin range widely over slope and abyssal waters (*e.g.,* Waring *et al.,* 2016; Roberts *et al.,* 2016), while the rough-toothed dolphin does not appear bound by water depth in its range (Ritter, 2002; Wells *et al.,* 2008). Our proposed mitigation largely eliminates potential effects to depleted coastal stocks of bottlenose dolphin, and provides substantial benefit to the on-shelf portion of the Atlantic spotted dolphin population. We also expect that meaningful subsidiary benefit will accrue to certain species from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales, most notably to species presumed to have greater association with shelf break waters north of Cape Hatteras (*e.g.,* offshore bottlenose dolphins, common dolphins, and Risso's dolphins). In consideration of these factors—overall impact ratings and proposed mitigation—we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on remaining delphinid species (*i.e.,* all stocks of bottlenose dolphin, two species of spotted dolphin, rough-toothed dolphin, striped dolphin, common dolphin, Clymene dolphin, and Risso's dolphin).

For those species with de minimis impact ratings we believe that, absent additional relevant concerns related to population status or context, the rating implies that a negligible impact should be expected as a result of the specified activity. No such concerns exist for these species, and we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on the humpback whale, minke whale, and harbor porpoise.

In summary, based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that the total marine mammal take from Spectrum's proposed survey activities will have a negligible impact on all affected marine mammal species or stocks.

TGS—TGS proposes a 308-day survey program, or 84 percent of the year (slightly more than three seasons). However, the proposed survey would cover a large spatial extent (*i.e.,* a majority of the mid- and south Atlantic; see Figures 1–1 to 1–4 of TGS's application). Therefore, although the survey would be long-term (*i.e.,* greater than one season) in total duration, we would not expect the duration of effect to be greater than moderate and intermittent in any given area. We note that TGS proposes to deploy two independent source vessels, which would in effect increase the spatial extent of survey noise at any one time but, because the vessels would not be operating within the same area or reshooting lines already covered, this would not be expected to increase the duration or frequency of exposure experienced by individual animals. Table 15 displays relevant information leading to impact ratings for each species resulting from TGS's proposed survey. In general, we note that although the temporal and spatial scale of the proposed survey activity is large, the fact that the mobile acoustic sources would be moving across large areas (as compared with geophysical surveys with different objectives that may require focused effort over long periods of time in smaller areas) means that many individuals may receive limited exposure to survey noise. The nature of such potentially transitory exposure (which we nevertheless assume here is of moderate duration and intermittent, versus isolated) means that the potential significance of behavioral disruption and potential for longer-term avoidance of important areas is limited.

TABLE 15—MAGNITUDE AND IMPACT RATINGS, TGS

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
North Atlantic right whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Humpback whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Minke whale	De minimis	Low-High	De minimis	n/a	De minimis.
Fin whale	High	Low	High	Medium	High.
Sperm whale	High	Moderate	High	Medium	High.
Kogia spp	High	High	High	Low	Moderate.
Beaked whales	High	Moderate	High	High	High.
Rough-toothed dolphin	High	High	High	Low	Moderate.
Common bottlenose dolphin	High	High	High	Low	Moderate.
Clymene dolphin	Low	High	High	Low	Moderate.
Atlantic spotted dolphin	High	Moderate	High	Low	Moderate.
Pantropical spotted dolphin	High	High	High	Low	Moderate.
Striped dolphin	High	Low	High	Low	Moderate.
Short-beaked common dolphin	High	Low-moderate	High	Low	Moderate.
Risso's dolphin	High	Low-moderate	High	Low	Moderate.
Pilot whales	High	Moderate	High	Medium	High.
Harbor porpoise	De minimis	Low	De minimis	n/a	De minimis.

The North Atlantic right whale is endangered, has a very low population size, and faces significant additional stressors. Therefore, regardless of impact rating, we believe that the proposed mitigation described previously is important in order for us to make the necessary finding and, in consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on the North Atlantic right whale. The fin whale receives a high impact rating overall, due to the high amount of exposure predicted for TGS's proposed survey activity. As described previously, we expect that for two seasons (summer and fall) almost no fin whales will be present in the proposed survey area and that, for the remainder of the year, it is likely that less than one quarter of the population will be present within the proposed survey area (Roberts *et al.,* 2016), meaning that these impacts would be experienced by only a small subset of the overall population. However, given the high amount of predicted exposure, we believe that additional mitigation requirements are warranted and propose that TGS be subject to a shutdown requirement for fin whales. If the observed fin whale is within the behavioral harassment zone, it would still be considered to have experienced harassment, but by immediately shutting down the acoustic source the duration of harassment is minimized and the significance of the harassment event reduced as much as possible. In consideration of the likely proportion of the population that may be affected by the specified activities, the lack of evidence that the proposed survey area is host to important behavior that may be disrupted, and the proposed mitigation, we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on the fin whale.

Magnitude ratings for the sperm whale, beaked whales, and pilot whales are high and, further, consequence factors reinforce high impact ratings for all three. In addition, regardless of impact rating, the consideration of likely consequences and contextual factors leads us to conclude that targeted mitigation is important to support a finding that the effects of the proposed survey will have a negligible impact on these species. As described previously, sperm whales are an endangered species with particular susceptibility to disruption of foraging behavior, beaked whales are particularly acoustically sensitive (with presumed low compensatory ability), and pilot whales are sensitive to additional stressors due to a high degree of mortality in commercial fisheries (and also with low compensatory ability). Finally, due to their acoustic sensitivity, we have proposed shutdown of the acoustic source upon observation of a beaked whale at any distance from the source vessel. In consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on the sperm whale, beaked whales (*i.e., Ziphius cavirostris* and *Mesoplodon* spp.), and pilot whales (*i.e., Globicephala* spp.).

Kogia spp. receive a moderate impact rating. However, although NMFS does not currently identify a trend for these populations, recent survey effort and stranding data show a simultaneous increase in at-sea abundance and strandings, suggesting growing *Kogia* spp. abundance (NMFS, 2011; 2013a; Waring *et al.,* 2007; 2013). Finally, we expect that *Kogia* spp. will receive subsidiary benefit from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales and, although minimally effective due to the difficulty of at-sea observation of *Kogia* spp., we have proposed shutdown of the acoustic source upon observation of *Kogia* spp. at any distance from the source vessel. In consideration of these factors—likely population increase and proposed mitigation—we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on *Kogia* spp.

Despite high magnitude ratings, remaining delphinid species receive moderate impact ratings due to a lack of propensity for behavioral disruption due to geophysical survey activity and our expectation that these species would generally have relatively high compensatory ability. In addition, these species do not have significant issues relating to population status or context. Many oceanic delphinid species are generally more associated with dynamic oceanographic characteristics rather than static physical features, and those species (such as common dolphin) with substantial distribution to the north of the proposed survey area would likely be little affected at the population level by the proposed activity. For example, both species of spotted dolphin and the offshore stock of bottlenose dolphin range widely over slope and abyssal waters (*e.g.,* Waring *et al.,* 2016; Roberts *et al.,* 2016), while the rough-toothed dolphin does not appear bound by water depth in its range (Ritter, 2002; Wells *et al.,* 2008). Our proposed mitigation largely eliminates potential effects to depleted coastal stocks of bottlenose dolphin, and provides substantial benefit to the on-shelf portion of the Atlantic spotted dolphin population. We also expect that meaningful subsidiary benefit will accrue to certain species from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales, most notably to species presumed to have greater association with shelf break waters north of Cape Hatteras (*e.g.,* offshore bottlenose dolphins, common dolphins, and Risso's dolphins). In consideration of these factors—overall impact ratings and proposed mitigation—we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on remaining delphinid species (*i.e.,* all stocks of bottlenose dolphin, two species of spotted dolphin, rough-toothed dolphin, striped dolphin, common dolphin, Clymene dolphin, and Risso's dolphin).

For those species with de minimis impact ratings we believe that, absent additional relevant concerns related to population status or context, the rating implies that a negligible impact should be expected as a result of the specified activity. No such concerns exist for these species, and we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on the humpback whale, minke whale, and harbor porpoise.

In summary, based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that the total marine mammal take from TGS's proposed survey activities will have a negligible impact on all affected marine mammal species or stocks.

ION—ION proposes a 70-day survey program, or 19 percent of the year (slightly less than one season). However, the proposed survey would cover a large spatial extent (*i.e.,* a majority of the mid- and south Atlantic; see Figure 1 of ION's application). Therefore, although the survey would be moderate-term (*i.e.,* from 1–3 months) in total duration, we would not expect the duration of effect to be greater than short and isolated to intermittent in any given area. Table 16 displays relevant information leading to impact ratings for each species resulting from ION's proposed survey. In general, we note that although the spatial scale of the proposed survey activity is large, the fact that this mobile acoustic source would be moving across large areas (as compared with geophysical surveys with different objectives that may require focused effort over long periods of time in smaller areas) means that many individuals may receive limited exposure to survey noise. The nature of such potentially transitory exposure means that the potential significance of behavioral disruption and potential for longer-term avoidance of important areas is limited.

TABLE 16—MAGNITUDE AND IMPACT RATINGS, ION

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
North Atlantic right whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Humpback whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Minke whale	De minimis	Low-High	De minimis	n/a	De minimis.
Fin whale	De minimis	Low	De minimis	n/a	De minimis.
Sperm whale	De minimis	Moderate	De minimis	n/a	De minimis.
Kogia spp	De minimis	High	De minimis	n/a	De minimis.
Beaked whales	De minimis	Moderate	De minimis	n/a	De minimis.

TABLE 16—MAGNITUDE AND IMPACT RATINGS, ION—Continued

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
Rough-toothed dolphin	De minimis	High	De minimis	n/a	De minimis.
Common bottlenose dolphin	De minimis	High	De minimis	n/a	De minimis.
Clymene dolphin	De minimis	High	De minimis	n/a	De minimis.
Atlantic spotted dolphin	De minimis	Moderate	De minimis	n/a	De minimis.
Pantropical spotted dolphin	De minimis	High	De minimis	n/a	De minimis.
Striped dolphin	De minimis	Low	De minimis	n/a	De minimis.
Short-beaked common dolphin	De minimis	Low-moderate	De minimis	n/a	De minimis.
Risso's dolphin	De minimis	Low-moderate	De minimis	n/a	De minimis.
Pilot whales	De minimis	Moderate	De minimis	n/a	De minimis.
Harbor porpoise	De minimis	Low	De minimis	n/a	De minimis.

The North Atlantic right whale is endangered, has a very low population size, and faces significant additional stressors. Therefore, regardless of impact rating, we believe that the proposed mitigation described previously is important in order for us to make the necessary finding and, in consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from ION's proposed survey activities will have a negligible impact on the North Atlantic right whale.

Also regardless of impact rating, consideration of assumed behavioral susceptibility and lack of compensatory ability (*i.e.,* the consequence factors that are disregarded in our matrix assessment for ION) as well as additional contextual factors leads us to conclude that the proposed targeted time-area mitigation described previously is important to support a finding that the effects of the proposed survey will have a negligible impact for the sperm whale, beaked whales (*i.e., Ziphius cavirostris* and *Mesoplodon* spp.), and pilot whales (*i.e., Globicephala* spp.). As described previously, sperm whales are an endangered species with particular susceptibility to disruption of foraging behavior, beaked whales are particularly acoustically sensitive, and pilot whales are sensitive to additional stressors due to a high degree of mortality in commercial fisheries. Further, we expect that compensatory ability for beaked whales will be low due to presumed residency in certain shelf break and deepwater canyon areas covered by the proposed survey area and that compensatory ability for pilot whales will also be low due to presumed residency in areas targeted by the proposed survey. *Kogia* spp. are also considered to have heightened acoustic sensitivity and therefore we have proposed shutdown of the acoustic source upon observation of a beaked whale or a *Kogia* spp. at any distance from the source vessel. In consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from ION's proposed survey activities will have a negligible impact on the sperm whale, beaked whales, pilot whales, and *Kogia* spp.

For those species with de minimis impact ratings we believe that, absent additional relevant concerns related to population status or context, the rating implies that a negligible impact should be expected as a result of the specified activity. No such concerns exist for these species, and we preliminarily find that the total marine mammal take from ION's proposed survey activities will have a negligible impact on all stocks of bottlenose dolphin, two species of spotted dolphin, rough-toothed dolphin, striped dolphin, common dolphin, Clymene dolphin, Risso's dolphin humpback whale, minke whale, fin whale, and harbor porpoise.

In summary, based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that the total marine mammal take from ION's proposed survey activities will have a negligible impact on all affected marine mammal species or stocks.

Western—Western proposes a 208-day survey program, or 57 percent of the year (slightly more than two seasons). However, the proposed survey would cover a large spatial extent (*i.e.,* a majority of the mid- and south Atlantic; see Figures 1–1 to 1–4 of Western's application). Therefore, although the survey would be long-term (*i.e.,* greater than one season) in total duration, we would not expect the duration of effect to be greater than moderate and intermittent in any given area. Table 17 displays relevant information leading to impact ratings for each species resulting from Western's proposed survey. In general, we note that although the temporal and spatial scale of the proposed survey activity is large, the fact that this mobile acoustic source would be moving across large areas (as compared with geophysical surveys with different objectives that may require focused effort over long periods of time in smaller areas) means that many individuals may receive limited exposed to survey noise. The nature of such potentially transitory exposure (which we nevertheless assume here is of moderate duration and intermittent, versus isolated) means that the potential significance of behavioral disruption and potential for longer-term avoidance of important areas is limited.

TABLE 17—MAGNITUDE AND IMPACT RATINGS, WESTERN

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
North Atlantic right whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Humpback whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Minke whale	De minimis	Low-High	De minimis	n/a	De minimis.
Fin whale	Low	Low	Medium	Medium	Moderate.
Sperm whale	High	Moderate	High	Medium	High.
Kogia spp	Low	High	High	Low	Moderate.
Beaked whales	High	Moderate	High	High	High.
Rough-toothed dolphin	Moderate	High	High	Low	Moderate.

TABLE 17—MAGNITUDE AND IMPACT RATINGS, WESTERN—Continued

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
Common bottlenose dolphin	Moderate	High	High	Low	Moderate.
Clymene dolphin	De minimis	High	De minimis	n/a	De minimis.
Atlantic spotted dolphin	High	Moderate	High	Low	Moderate.
Pantropical spotted dolphin	Moderate	High	High	Low	Moderate.
Striped dolphin	Low	Low	Medium	Low	Low.
Short-beaked common dolphin	Low	Low-moderate	Medium	Low	Low.
Risso's dolphin	Moderate	Low-moderate	High	Low	Moderate.
Pilot whales	Moderate	Moderate	High	Medium	High.
Harbor porpoise	De minimis	Low	De minimis	n/a	De minimis.

The North Atlantic right whale is endangered, has a very low population size, and faces significant additional stressors. Therefore, regardless of impact rating, we believe that the proposed mitigation described previously is important in order for us to make the necessary finding and, in consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on the North Atlantic right whale. The fin whale receives a moderate impact rating overall, but we expect that for two seasons (summer and fall) almost no fin whales will be present in the proposed survey area. For the remainder of the year, it is likely that less than one quarter of the population will be present within the proposed survey area (Roberts *et al.,* 2016), meaning that despite medium rankings for magnitude and likely consequences, these impacts would be experienced by only a small subset of the overall population. In consideration of the moderate impact rating, the likely proportion of the population that may be affected by the specified activities, and the lack of evidence that the proposed survey area is host to important behavior that may be disrupted, we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on the fin whale.

Magnitude ratings for the sperm whale, beaked whales, and pilot whales are high and, further, consequence factors reinforce high impact ratings for all three. In addition, regardless of impact rating, the consideration of likely consequences and contextual factors leads us to conclude that targeted mitigation is important to support a finding that the effects of the proposed survey will have a negligible impact on these species. As described previously, sperm whales are an endangered species with particular susceptibility to disruption of foraging behavior, beaked whales are particularly acoustically sensitive (with presumed low compensatory ability), and pilot whales are sensitive to additional stressors due to a high degree of mortality in commercial fisheries (and also with low compensatory ability). Finally, due to their acoustic sensitivity, we have proposed shutdown of the acoustic source upon observation of a beaked whale at any distance from the source vessel. In consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on the sperm whale, beaked whales (*i.e., Ziphius cavirostris* and *Mesoplodon* spp.), and pilot whales (*i.e., Globicephala* spp.).

Kogia spp. receive a moderate impact rating. However, although NMFS does not currently identify a trend for these populations, recent survey effort and stranding data show a simultaneous increase in at-sea abundance and strandings, suggesting growing *Kogia* spp. abundance (NMFS, 2011; 2013a; Waring *et al.,* 2007; 2013). Finally, we expect that *Kogia* spp. will receive subsidiary benefit from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales and, although minimally effective due to the difficulty of at-sea observation of *Kogia* spp., we have proposed shutdown of the acoustic source upon observation of *Kogia* spp. at any distance from the source vessel. In consideration of these factors—likely population increase and proposed mitigation—we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on *Kogia* spp.

Despite medium to high magnitude ratings (with the exception of the Clymene dolphin), remaining delphinid species receive low to moderate impact ratings due to a lack of propensity for behavioral disruption due to geophysical survey activity and our expectation that these species would generally have relatively high compensatory ability. In addition, these species do not have significant issues relating to population status or context. Many oceanic delphinid species are generally more associated with dynamic oceanographic characteristics rather than static physical features, and those species (such as common dolphin) with substantial distribution to the north of the proposed survey area would likely be little affected at the population level by the proposed activity. For example, both species of spotted dolphin and the offshore stock of bottlenose dolphin range widely over slope and abyssal waters (*e.g.,* Waring *et al.,* 2016; Roberts *et al.,* 2016), while the rough-toothed dolphin does not appear bound by water depth in its range (Ritter, 2002; Wells *et al.,* 2008). Our proposed mitigation largely eliminates potential effects to depleted coastal stocks of bottlenose dolphin, and provides substantial benefit to the on-shelf portion of the Atlantic spotted dolphin population. We also expect that meaningful subsidiary benefit will accrue to certain species from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales, most notably to species presumed to have greater association with shelf break waters north of Cape Hatteras (*e.g.,* offshore bottlenose dolphins, common dolphins, and Risso's dolphins). In consideration of these factors—overall impact ratings and proposed mitigation—we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on remaining delphinid species (*i.e.,* all stocks of bottlenose dolphin, two species of spotted dolphin, rough-toothed dolphin, striped dolphin, common dolphin, and Risso's dolphin).

For those species with de minimis impact ratings we believe that, absent additional relevant concerns related to population status or context, the rating implies that a negligible impact should be expected as a result of the specified activity. No such concerns exist for these species, and we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on the humpback whale, minke whale, Clymene dolphin, and harbor porpoise.

In summary, based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that the total marine mammal take from Western's proposed survey activities will have a negligible impact on all affected marine mammal species or stocks.

CGG—CGG proposes an approximately 155-day survey program, or 42 percent of the year (approximately two seasons). However, the proposed survey would cover a large spatial extent (*i.e.,* a majority of the mid- and south Atlantic; see Figure 3 of CGG's application). Therefore, although the survey would be long-term (*i.e.,* greater than one season) in total duration, we would not expect the duration of effect to be greater than moderate and intermittent in any given area. Table 18 displays relevant information leading to impact ratings for each species resulting from CGG's proposed survey. In general, we note that although the temporal and spatial scale of the proposed survey activity is large, the fact that this mobile acoustic source would be moving across large areas (as compared with geophysical surveys with different objectives that may require focused effort over long periods of time in smaller areas) means that many individuals may receive limited exposure to survey noise. The nature of such potentially transitory exposure means that the potential significance of behavioral disruption and potential for longer-term avoidance of important areas is limited.

TABLE 18—MAGNITUDE AND IMPACT RATINGS, CGG

Species	Amount	Spatial extent	Magnitude rating	Consequences	Impact rating
North Atlantic right whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Humpback whale	De minimis	Low-Moderate	De minimis	n/a	De minimis.
Minke whale	De minimis	Low-High	De minimis	n/a	De minimis.
Fin whale	De minimis	Low	De minimis	n/a	De minimis.
Sperm whale	High	Moderate	High	Medium	High.
Kogia spp	Low	High	High	Low	Moderate.
Beaked whales	High	Moderate	High	High	High.
Rough-toothed dolphin	High	High	High	Low	Moderate.
Common bottlenose dolphin	Low	High	High	Low	Moderate.
Clymene dolphin	High	High	High	Low	Moderate.
Atlantic spotted dolphin	Low	Moderate	Medium	Low	Low.
Pantropical spotted dolphin	High	High	High	Low	Moderate.
Striped dolphin	Low	Low	Medium	Low	Low.
Short-beaked common dolphin	De minimis	Low-moderate	De minimis	n/a	De minimis.
Risso's dolphin	Low	Low-moderate	Medium	Low	Low.
Pilot whales	Low	Moderate	Medium	Medium	Moderate.
Harbor porpoise	De minimis	Low	De minimis	n/a	De minimis.

The North Atlantic right whale is endangered, has a very low population size, and faces significant additional stressors. Therefore, regardless of impact rating, we believe that the proposed mitigation described previously is important in order for us to make the necessary finding and, in consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on the North Atlantic right whale.

Magnitude ratings for the sperm whale and beaked whales are high and, further, consequence factors reinforce high impact ratings for both. Magnitude rating for pilot whales is medium but, similar to beaked whales, we expect that compensatory ability will be low due to presumed residency in areas targeted by the proposed survey—leading to a moderate impact rating. However, regardless of impact rating, the consideration of likely consequences and contextual factors leads us to conclude that targeted mitigation is important to support a finding that the effects of the proposed survey will have a negligible impact on these species. As described previously, sperm whales are an endangered species with particular susceptibility to disruption of foraging behavior, beaked whales are particularly acoustically sensitive (with presumed low compensatory ability), and pilot whales are sensitive to additional stressors due to a high degree of mortality in commercial fisheries (and also with low compensatory ability). Finally, due to their acoustic sensitivity, we have proposed shutdown of the acoustic source upon observation of a beaked whale at any distance from the source vessel. In consideration of the proposed mitigation, we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on the sperm whale, beaked whales (*i.e., Ziphius cavirostris* and *Mesoplodon* spp.), and pilot whales (*i.e., Globicephala* spp.).

Kogia spp. receive a moderate impact rating. However, although NMFS does not currently identify a trend for these populations, recent survey effort and stranding data show a simultaneous increase in at-sea abundance and strandings, suggesting growing *Kogia* spp. abundance (NMFS, 2011; 2013a; Waring *et al.,* 2007; 2013). Finally, we expect that *Kogia* spp. will receive subsidiary benefit from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales and, although minimally effective due to the difficulty of at-sea observation of *Kogia* spp., we have proposed shutdown of the acoustic source upon observation of *Kogia* spp. at any distance from the source vessel. In consideration of these factors—likely population increase and proposed mitigation—we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on *Kogia* spp.

Despite medium to high magnitude ratings (with the exception of the short-beaked common dolphin), remaining delphinid species receive low to moderate impact ratings due to a lack of propensity for behavioral disruption due to geophysical survey activity and our expectation that these species would generally have relatively high compensatory ability. In addition, these species do not have significant issues relating to population status or context. Many oceanic delphinid species are generally more associated with dynamic oceanographic characteristics rather than static physical features, and those species (such as common dolphin) with substantial distribution to the north of the proposed survey area would likely be little affected at the population level by the proposed activity. For example, both species of spotted dolphin and the offshore stock of bottlenose dolphin range widely over slope and abyssal waters (*e.g.,* Waring *et al.,* 2016; Roberts *et al.,* 2016), while the rough-toothed dolphin does not appear bound by water depth in its range (Ritter, 2002; Wells *et al.,* 2008). Our proposed mitigation largely eliminates potential effects to depleted coastal stocks of bottlenose dolphin. We also expect that meaningful subsidiary benefit will accrue to certain species from the proposed mitigation targeted for sperm whales, beaked whales, and pilot whales, most notably to species presumed to have greater association with shelf break waters north of Cape Hatteras (*e.g.,* offshore bottlenose dolphins, common dolphins, and Risso's dolphins). In consideration of these factors—overall impact ratings and proposed mitigation—we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on remaining delphinid species (*i.e.,* all stocks of bottlenose dolphin, two species of spotted dolphin, rough-toothed dolphin, striped dolphin, Clymene dolphin, and Risso's dolphin).

For those species with de minimis impact ratings we believe that, absent additional relevant concerns related to population status or context, the rating implies that a negligible impact should be expected as a result of the specified activity. No such concerns exist for these species, and we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on the humpback whale, minke whale, fin whale, short-beaked common dolphin, and harbor porpoise.

In summary, based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that the total marine mammal take from CGG's proposed survey activities will have a negligible impact on all affected marine mammal species or stocks.

Small Numbers Analyses

Please see Tables 10 and 11 and the related text for information relating to the basis for our small numbers analyses. Table 10 provides the numbers of predicted exposures above specified received levels, while Table 11 provides numbers of take by Level A and Level B harassment proposed for authorization. The latter is what we consider for purposes of small numbers analysis for each proposed IHA. For the sei whale, Bryde's whale, blue whale, northern bottlenose whale, Fraser's dolphin, melon-headed whale, false killer whale, pygmy killer whale, killer whale, spinner dolphin, and white-sided dolphin, we propose to authorize take resulting from a single exposure of one group of each species or stock, as appropriate (using average group size), for each applicant. We believe that a single incident of take of one group of any of these species represents take of small numbers for that species. Therefore, for each applicant, based on the analyses contained herein of their specified activity, we preliminarily find that small numbers of marine mammals will be taken for each of these 11 affected species or stocks for each specified activity. We do not discuss these 11 species further in the applicant-specific analyses that follow.

As discussed previously, the MMPA does not define small numbers. NMFS compares the estimated numbers of individuals expected to be taken to the most appropriate estimation of the relevant species or stock size in our determination of whether an authorization is limited to small numbers of marine mammals. In that regard, NMFS proposes to limit its authorization of take to 30 percent of the most appropriate stock abundance estimate, assuming no other relevant factors that provide more context for the estimate, *e.g.,* information that the take numbers represent instances of multiple exposures of the same animals. For these proposed IHAs, the proposed take authorizations (Table 11) have been limited to a threshold of 30 percent. In order to limit actual take to this proportion of estimated stock abundance, we propose to require monthly reporting from those applicants with predicted exposures of any species exceeding this threshold (*i.e.,* Spectrum, TGS, CGG, and Western). These interim reports would include amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken.'' Upon reaching the pre-determined take threshold, any issued IHA would be withdrawn. This proposed mechanism to limit actual take is discussed further under ''Proposed Monitoring and Reporting.''

In addition, we have proposed time-area restrictions targeted at certain species (see ''Proposed Mitigation''). In particular, one such proposed restriction is targeted towards on-shelf Atlantic spotted dolphins specifically to reduce the likely number of individuals taken. This measure is proposed for implementation for Spectrum, TGS, and Western, due to the uniformly high number of predicted exposures of Atlantic spotted dolphins across all three applicants. In addition, we have proposed time-area restrictions targeted towards sperm whales, beaked whales, and pilot whales. While these restrictions are primarily intended to provide protections important to our preliminary negligible impact findings for each applicant, they would also be expected to reduce the total number of individuals taken (of the three target species/guilds as well as other species likely to be present in those areas). While we are unable to quantify the likely reduction in individuals taken as a result of the proposed mitigation, we believe that the combination of the proposed mitigation and the controls on taking through proposed monitoring and reporting requirements will be effective in limiting the taking of individuals of any species to small numbers. Applicant-specific analyses follow.

Spectrum—The total amount of taking proposed for authorization for a majority of affected stocks ranges from 1 to 24 percent of the most appropriate population abundance estimate. The total amount of taking proposed for authorization for remaining stocks (*i.e.,* rough-toothed dolphin, bottlenose dolphin, Clymene dolphin, Atlantic spotted dolphin, and pantropical spotted dolphin) is limited to 30 percent of the most appropriate population abundance estimate, through mitigation and monitoring mechanisms described previously.

Based on the analysis contained herein of Spectrum's specified activity, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that small numbers of marine mammals will be taken relative to each of the affected species or stocks.

TGS—The total amount of taking proposed for authorization for the harbor porpoise, North Atlantic right whale, humpback whale, minke whale, and Clymene dolphin ranges from one to nine percent of the most appropriate population abundance estimate. The total amount of taking proposed for authorization for all remaining stocks is limited to 30 percent of the most appropriate population abundance estimate, through mitigation and monitoring mechanisms described previously.

Based on the analysis contained herein of TGS's specified activity, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that small numbers of marine mammals will be taken relative to each of the affected species or stocks.

ION—The total amount of taking proposed for authorization for all affected stocks ranges from less than one to four percent of the most appropriate population abundance estimate. Therefore, based on the analysis contained herein of ION's specified activity, we preliminarily find that small numbers of marine mammals will be taken relative to each of the affected species or stocks.

Western—The total amount of taking proposed for authorization for a majority of affected stocks ranges from less than 1 to 25 percent of the most appropriate population abundance estimate. The total amount of taking proposed for authorization for remaining stocks (*i.e.,* sperm whale, beaked whales, and Atlantic spotted dolphin) is limited to 30 percent of the most appropriate population abundance estimate, through mitigation and monitoring mechanisms described previously.

Based on the analysis contained herein of Western's specified activity, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that small numbers of marine mammals will be taken relative to each of the affected species or stocks.

CGG—The total amount of taking proposed for authorization for a majority of affected stocks ranges from less than 1 to 26 percent of the most appropriate population abundance estimate. The total amount of taking proposed for authorization for remaining stocks (*i.e.,* rough-toothed dolphin, Clymene dolphin, and pantropical spotted dolphin) is limited to 30 percent of the most appropriate population abundance estimate, through mitigation and monitoring mechanisms described previously.

Based on the analysis contained herein of CGG's specified activity, and taking into consideration the implementation of the proposed monitoring and mitigation measures, we preliminarily find that small numbers of marine mammals will be taken relative to each of the affected species or stocks.

Proposed Monitoring and Reporting

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth ''requirements pertaining to the monitoring and reporting of such taking.'' The MMPA implementing regulations at 50 CFR 216.104 (a)(13) indicate that requests for incidental take authorizations must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area. Effective reporting is critical both to compliance as well as ensuring that the most value is obtained from the required monitoring.

Any monitoring requirement we prescribe should improve our understanding of one or more of the following:

- Occurrence of marine mammal species in action area (*e.g.,* presence, abundance, distribution, density).
- Nature, scope, or context of likely marine mammal exposure to potential stressors/impacts (individual or cumulative, acute or chronic), through better understanding of: (1) Action or environment (*e.g.,* source characterization, propagation, ambient noise); (2) affected species (*e.g.,* life history, dive patterns); (3) co-occurrence of marine mammal species with the action; or (4) biological or behavioral context of exposure (*e.g.,* age, calving or feeding areas).
- Individual responses to acute stressors, or impacts of chronic exposures (behavioral or physiological).
- How anticipated responses to stressors impact either: (1) Long-term fitness and survival of an individual; or (2) population, species, or stock.
- Effects on marine mammal habitat and resultant impacts to marine mammals.
- Mitigation and monitoring effectiveness.

Proposed monitoring requirements are the same for all applicants (except as noted), and a single discussion is provided here.

PSO Eligibility and Qualifications

All PSO resumes must be submitted to NMFS and PSOs must be approved by NMFS after a review of their qualifications. PSOs should provide a current resume and information related to PSO training, if available. The latter should include (1) a course information packet that includes the name and qualifications (*e.g.,* experience, training, or education) of the instructor(s), the course outline or syllabus, and course reference material; and (2) a document stating successful completion of the course. PSOs must be trained biologists, with the following minimum qualifications:

- A bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics;
- Experience and ability to conduct field observations and collect data according to assigned protocols (may include academic experience; required for visual PSOs only) and experience with data entry on computers;
- Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface with ability to estimate target size and distance; use of binoculars may be necessary to correctly identify the target (required for visual PSOs only);
- Experience or training in the field identification of marine mammals, including the identification of behaviors (required for visual PSOs only);
- Sufficient training, orientation, or experience with the survey operation to provide for personal safety during observations;
- Writing skills sufficient to prepare a report of observations including but not limited to the number and species of marine mammals observed; marine mammal behavior; and descriptions of activity conducted and implementation of mitigation;
- Ability to communicate orally, by radio or in person, with survey personnel to provide real-time information on marine mammals observed in the area as necessary; and
- Successful completion of relevant training (described below), including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification, and prospective PSOs granted waivers must satisfy training requirements described below. Alternate experience that may be considered includes, but is not limited to, the following:

- Secondary education and/or experience comparable to PSO duties.
- Previous work experience conducting academic, commercial, or

government-sponsored marine mammal surveys.

• Previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

Training—NMFS does not currently approve specific training programs; however, acceptable training may include training previously approved by BSEE, or training that adheres generally to the recommendations provided by Baker *et al.* (2013). Those recommendations include the following topics for training programs:

• Life at sea, duties, and authorities;
• Ethics, conflicts of interest, standards of conduct, and data confidentiality;
• Offshore survival and safety training;
• Overview of oil and gas activities (including geophysical data acquisition operations, theory, and principles) and types of relevant sound source technology and equipment;
• Overview of the MMPA and ESA as they relate to protection of marine mammals;
• Mitigation, monitoring, and reporting requirements as they pertain to geophysical surveys;
• Marine mammal identification, biology and behavior;
• Background on underwater sound;
• Visual surveying protocols, distance calculations and determination, cues, and search methods for locating and tracking different marine mammal species (visual PSOs only);
• Optimized deployment and configuration of PAM equipment to ensure effective detections of cetaceans for mitigation purposes (PAM operators only);
• Detection and identification of vocalizing species or cetacean groups (PAM operators only);
• Measuring distance and bearing of vocalizing cetaceans while accounting for vessel movement (PAM operators only);
• Data recording and protocols, including standard forms and reports, determining range, distance, direction, and bearing of marine mammals and vessels; recording GPS location coordinates, weather conditions, Beaufort wind force and sea state, etc.;
• Proficiency with relevant software tools;
• Field communication/support with appropriate personnel, and using communication devices (*e.g.,* two-way radios, satellite phones, Internet, email, facsimile);
• Reporting of violations, noncompliance, and coercion; and
• Conflict resolution.

PAM operators should regularly refresh their detection skills through practice with simulation-modelling software, and should keep up to date with training on the latest software/hardware advances.

Visual Monitoring

The lead PSO is responsible for establishing and maintaining clear lines of communication with vessel crew. The vessel operator shall work with the lead PSO to accomplish this and shall ensure any necessary briefings are provided for vessel crew to understand mitigation requirements and protocols. While on duty, PSOs would continually scan the water surface in all directions around the acoustic source and vessel for presence of marine mammals, using a combination of the naked eye and high-quality binoculars, from optimum vantage points for unimpaired visual observations with minimum distractions. PSOs would collect observational data for all marine mammals observed, regardless of distance from the vessel, including species, group size, presence of calves, distance from vessel and direction of travel, and any observed behavior (including an assessment of behavioral responses to survey activity). Upon observation of marine mammal(s), a PSO would record the observation and monitor the animal's 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, and a PSO would continue to observe the area to watch for the animal to resurface or for additional animals that may surface in the area. PSOs would also record environmental conditions at the beginning and end of the observation period and at the time of any observations, as well as whenever conditions change significantly in the judgment of the PSO on duty.

The vessel operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These should be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. NVDs may include night vision binoculars or monocular or forward-looking infrared device (*e.g.,* Exelis PVS–7 night vision goggles; Night Optics D–300 night vision monocular; FLIR M324XP thermal imaging camera or equivalents). At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations. Other required equipment, which should be made available to PSOs by the third-party observer provider, includes reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform the tasks described above, including accurate determination of distance and bearing to observed marine mammals.

Individuals implementing the monitoring protocol will assess its effectiveness using an adaptive approach. Monitoring biologists will use their best professional judgment throughout implementation and seek improvements to these methods when deemed appropriate. Any modifications to protocol will be coordinated between NMFS and the applicant.

Acoustic Monitoring

Monitoring of a towed PAM system is required at all times, from 30 minutes prior to ramp-up and throughout all use of the acoustic source. Towed PAM systems generally consist of hardware (*e.g.,* hydrophone array, cables) and software (*e.g.,* data processing and monitoring system). While not required, we recommend use of industry standard software (*e.g.,* PAMguard, which is open source). Hydrophone signals are processed for output to the PAM operator with software designed to detect marine mammal vocalizations. Current PAM technology has some limitations (*e.g.,* limited directional capabilities and detection range, masking of signals due to noise from the vessel, source, and/or flow, localization) and there are no formal guidelines currently in place regarding specifications for hardware, software, or operator training requirements. However, a working group (led by A.M. Thode) is developing formal standards under the auspices of the Acoustical Society of America's (ASA) Accredited Standards Committee on Animal Bioacoustics (ANSI S3/SC1/WG3; ''Towed Array Passive Acoustic Operations for Bioacoustics Applications''). While no formal standards have yet been completed, a ''roadmap'' was developed during a 2016 workshop held for the express purpose of continuing development of such standards. A workshop report (Thode *et al.,* 2017) provides a highly detailed preview of what the scope and structure of the standard would be, including operator training, planning, hardware, real-time operations, localization, and performance validation. NMFS will review this document, and recommends that applicants do the same in developing or refining their PAM plans, as appropriate.

Our requirement to use PAM refers to the use of calibrated hydrophone arrays with full system redundancy to detect, identify and estimate distance and bearing to vocalizing cetaceans, to the extent possible. With regard to calibration, the PAM system should have at least one calibrated hydrophone, sufficient for determining whether background noise levels on the towed PAM system are sufficiently low to meet performance expectations. Additionally, if multiple hydrophone types occur in a system (*i.e.,* monitor different bandwidths), then one hydrophone from each such type should be calibrated, and whenever sets of hydrophones (of the same type) are sufficiently spatially separated such that they would be expected to experience ambient noise environments that differ by 6 dB or more across any integrated species cluster bandwidth, then at least one hydrophone from each set should be calibrated. The arrays should incorporate appropriate hydrophone elements (1 Hz to 180 kHz range) and sound data acquisition card technology for sampling relevant frequencies (*i.e.,* to 360 kHz). This hardware should be coupled with appropriate software to aid monitoring and listening by a PAM operator skilled in bioacoustics analysis and computer system specifications capable of running appropriate software. In the absence of a formally defined set of prescriptions addressing any of these three facets of PAM technology, all applicants must provide a description of the hardware and software proposed for use prior to proceeding with any BOEM-permitted survey. Applicant-specific PAM plans are available for review online at: *www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.* Spectrum and ION submitted separate plans, while TGS and Western included their plans in Section 11 of their respective applications. CGG discusses PAM in Section 13 of their application. As noted above, we recommend that each applicant produce a revised plan prior to a final decision on these requests. As recommended by Thode *et al.* (2017), the revised plans should, at minimum, adequately address and describe (1) the hardware and software planned for use, including a hardware performance diagram demonstrating that the sensitivity and dynamic range of the hardware is appropriate for the operation; (2) deployment methodology, including target depth/tow distance; (3) definitions of expected operational conditions, used to summarize background noise statistics; (4) proposed detection-classification-localization methodology, including anticipated species clusters (using a cluster definition table), target minimum detection range for each cluster, and the proposed localization method for each cluster; (5) operation plans, including the background noise sampling schedule; and (6) cluster-specific details regarding which real-time displays and automated detectors the operator would monitor.

In coordination with vessel crew, the lead PAM operator should be responsible for deployment, retrieval, and testing and optimization of the hydrophone array. While on duty, the PAM operator should diligently listen to received signals and/or monitoring display screens in order to detect vocalizing cetaceans, except as required to attend to PAM equipment. The PAM operator should use appropriate sample analysis and filtering techniques and, as described below, must report all cetacean detections. While not required prior to development of formal standards for PAM use, we recommend that vessel self-noise assessments are undertaken during mobilization in order to optimize PAM array configuration according to the specific noise characteristics of the vessel and equipment involved, and to refine expectations for distance/bearing estimations for cetacean species during the survey. Copies of any vessel self-noise assessment reports should be included with the summary trip report.

Data Collection

PSOs must use standardized data forms, whether hard copy or electronic. PSOs will record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

- Vessel names (source vessel and other vessels associated with survey) and call signs
- PSO names and affiliations
- Dates of departures and returns to port with port name
- Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort
- Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts
- Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change
- Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon
- Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)
- Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)
- If a marine mammal is sighted, the following information should be recorded:
  - Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)
  - PSO who sighted the animal
  - Time of sighting
  - Vessel location at time of sighting
  - Water depth
  - Direction of vessel's travel (compass direction)
  - Direction of animal's travel relative to the vessel
  - Pace of the animal
  - Estimated distance to the animal and its heading relative to vessel at initial sighting
  - Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species
  - Estimated number of animals (high/low/best)
  - Estimated number of animals by cohort (adults, yearlings, juveniles,

calves, group composition, etc.)
  - Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)
  - Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)
  - Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;
  - Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)
  - Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

- If a marine mammal is detected while using the PAM system, the following information should be recorded:
  - An acoustic encounter identification number, and whether the detection was linked with a visual sighting
  - Time when first and last heard
  - Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)
  - Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

Reporting

PSO effort, survey details, and sightings data should be recorded continuously during surveys and reports prepared each day during which survey effort is conducted. As described previously, applicants with predicted exposures of any species exceeding the 30-percent threshold (*i.e.,* Spectrum, TGS, CGG, and Western) must submit regular interim reports. These interim reports would include amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken.'' We propose submission of such interim reports to NMFS on a monthly basis.

There are multiple reasons why marine mammals may be present and yet be undetected by observers. Animals are missed because they are underwater (availability bias) or because they are available to be seen, but are missed by observers (perception and detection biases) (*e.g.,* Marsh and Sinclair, 1989). Negative bias on perception or detection of an available animal may result from environmental conditions, limitations inherent to the observation platform, or observer ability. In this case, we do not have prior knowledge of any potential negative bias on detection probability due to observation platform or observer ability. Therefore, observational data corrections must be made with respect to assumed species-specific detection probability as evaluated through consideration of environmental factors (*e.g.,* $f(0)$). We propose that corrections be made using detection probabilities found in Carr *et al.* (2011), which are based on $f(0)$ values from line-transect survey studies described in Koski *et al.* (1998), Barlow (1999), and Thomas *et al.* (2002). Carr *et al.* (2011) derived detection probabilities (shown in Table 19) as follows:

- $1/f(0)$ is the effective strip width.
- The effective strip width was divided by the truncation distance used to calculate $f(0)$.
- This value is detection probability or the average probability that an animal would be seen within the truncation distance from the vessel.
- For cryptic species where only sea states 0 to 2 were used to calculate $f(0)$, detection probability was arbitrarily divided by 3 to account for the higher probability that animals would be missed during the survey whenever sea states were greater than 2.
- Different detection probability values were calculated for groups with 1–16, 17–60 and greater than 60 individuals based on the different $f(0)$ values for those group sizes.
- The mean group size for the species or guild determined the appropriate detection probability that was used for that species or guild.

TABLE 19—DETECTION PROBABILITIES

Common name	Detection probability	Assumed group size
Mysticete whales (except minke whale)	0.259	1–16
Minke whale	0.244	1–16
Sperm whale	0.259	1–16
Kogia spp.	0.055	1–16
Beaked whales	0.244	1–16
Small delphinids, medium group size (all but common, spinner, and Fraser's dolphin)	0.524	17–60
Small delphinids, large group size	0.926	>60
Large delphinids, small group size (all but Risso's dolphin and killer whale)	0.309	1–16
Large delphinids, medium group size	0.524	17–60
Harbor porpoise	0.055	1–16

Adapted from Table B–6, Carr *et al.* (2011).

A draft comprehensive report would be submitted to NMFS within 90 days of the completion of survey effort, and must include all information described above under ''Data Collection.'' The report will describe the operations conducted and sightings of marine mammals near the operations. The report will provide full documentation of methods, results, and interpretation pertaining to all monitoring. The report will summarize the dates and locations of survey operations, and all marine mammal sightings (dates, times, locations, activities, associated survey activities); geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. This report must also include a validation document concerning the use of PAM, which should include necessary noise validation diagrams and demonstrate whether background noise levels on the PAM deployment limited achievement of the planned detection goals.

The report will also include estimates of the number of takes based on the observations and in consideration of the detectability of the marine mammal species observed (*e.g.,* in consideration of *f*(0)). Applicants must provide an estimate of the number (by species) of marine mammals that may have been exposed (based on observational data and accounting for animals present but unavailable for sighting (*i.e., f*(0) values)) to the survey activity at received levels greater than or equal to the harassment threshold (*i.e.,* 160 dB rms). The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report. A final report must be submitted within 30 days following resolution of any comments on the draft report.

In the event that the specified activity clearly causes the take of a marine mammal in a manner not permitted by the authorization (if issued), such as a serious injury or mortality, the applicant shall immediately cease the specified activities and immediately report the take to NMFS. The report must include the following information:

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

The applicant shall not resume its activities until NMFS is able to review the circumstances of the prohibited take. NMFS would work with the applicant to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. The applicant may not resume their activities until notified by NMFS.

In the event that the applicant discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (*i.e.,* in less than a moderate state of decomposition as we describe in the next paragraph), the applicant will immediately report the incident to NMFS. The report must include the same information identified in the paragraph above this section. Activities may continue while NMFS reviews the circumstances of the incident. NMFS would work with the applicant to determine whether modifications to the activities are appropriate.

In the event that the applicant discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), the applicant would report the incident to NMFS within 24 hours of the discovery. The applicant would provide photographs or video footage (if available) or other documentation of the animal to NMFS.

Impact on Availability of Affected Species for Taking for Subsistence Uses

There are no relevant subsistence uses of marine mammals implicated by these actions. Therefore, relevant to the Spectrum, TGS, ION, CGG, and Western proposed IHAs, we have determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes.

Endangered Species Act (ESA)

There are six marine mammal species listed as endangered under the ESA that may occur in the proposed survey areas. Under section 7 of the ESA, BOEM requested initiation of formal consultation (on behalf of itself and BSEE) in 2012 with NMFS's Office of Protected Resources, Endangered Species Act Interagency Cooperation Division (Interagency Cooperation Division) on the proposed authorization of geological and geophysical survey activities under its oil and gas, renewable energy and marine minerals programs. These activities were described in BOEM's Draft PEIS for Atlantic OCS Proposed Geological and Geophysical Activities in the Mid-Atlantic and South Atlantic Planning Areas. NMFS concluded formal consultation by issuing a final Biological Opinion to BOEM and BSEE on July 19, 2013, determining that the proposed activities were not likely to jeopardize the continued existence of threatened or endangered species nor destroy or adversely modify designated critical habitat under NMFS's jurisdiction. On October 16, 2015, BOEM and BSEE reinitiated consultation with NMFS.

NMFS's Office of Protected Resources, Permits and Conservation Division will also consult internally with Interagency Cooperation Division on the proposed issuance of authorizations under section 101(a)(5)(D) of the MMPA. NMFS will conclude the consultation prior to reaching a determination regarding the proposed issuance of the authorizations.

National Environmental Policy Act

In 2014, the BOEM produced a PEIS to evaluate potential significant environmental effects of G&G activities on the Mid- and South Atlantic OCS, pursuant to requirements of NEPA. These activities include geophysical surveys in support of hydrocarbon exploration, as are proposed in the MMPA applications before NMFS. The PEIS is available at: *www.boem.gov/Atlantic-G-G-PEIS/*. NMFS participated in development of the PEIS as a cooperating agency and believes it appropriate to adopt the analysis in order to assess the impacts to the human environment of issuance of the subject IHAs. Information in the IHA applications, BOEM's PEIS, and this notice collectively provide the environmental information related to proposed issuance of these IHAs for public review and comment. We will review all comments submitted in response to this notice as we complete the NEPA process, including a final decision of whether to adopt BOEM's PEIS and sign a Record of Decision related to issuance of IHAs, prior to a final decision on the incidental take authorization requests.

Proposed Authorizations

As a result of these preliminary determinations, we propose to issue five separate IHAs to the aforementioned applicant companies for conducting the described geophysical survey activities in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated. Specific language from the proposed IHAs is provided next.

This section contains drafts of the IHAs. The wording contained in this section is proposed for inclusion in the IHAs (if issued).

Spectrum

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in Spectrum's IHA application and using an array with characteristics specified in the application, in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas.

3. General Conditions

(a) A copy of this IHA must be in the possession of Spectrum, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of Spectrum operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11.

(c) The taking by serious injury or death of any of the species listed in Table 11 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) Spectrum shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations. Spectrum shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and protected species monitoring team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations.

(e) During use of the acoustic source, if the source vessel encounters any marine mammal species that are not listed in Table 11, then the acoustic source must be shut down to avoid unauthorized take.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) Spectrum must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a deep penetration seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One ''experienced'' visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that ''experienced'' PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience to the maximum extent practicable.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to acoustic PSOs, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(vi) Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, shall be relayed to the source vessel and to the PSO team.

(vii) During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation

(i) The source vessel must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(iv) Survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding small delphinoids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Buffer Zone and Exclusion Zone—The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown of the acoustic source. PSOs must monitor the buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance).

(f) Ramp-up—A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. Ramp-up may not be initiated if any marine mammal is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs would monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone. Ramp-up may occur at times of poor visibility if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups shall be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(g) Shutdown Requirements

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

(ii) Upon completion of ramp-up, if a marine mammal appears within, enters, or appears on a course to enter the exclusion zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the acoustic PSO is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement.

(A) This shutdown requirement is waived for dolphins of the following genera: *Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(iii) Shutdown of the acoustic source is required upon observation of a right whale at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

(v) Shutdown of the acoustic source is required upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel.

(vi) Shutdown of the acoustic source is required upon observation (visual or acoustic) of a beaked whale or *Kogia* spp. at any distance.

(vii) Shutdown of the acoustic source is required upon observation of an aggregation (*i.e.,* six or more animals) of marine mammals of any species that does not appear to be traveling.

(viii) Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdown due to observation of a right whale), a 30-minute clearance period must be observed following the last observation of the animal(s).

(ix) If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. For any longer shutdown, pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(h) Miscellaneous Protocols

(i) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up).

Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

(i) Closure Areas

(i) No use of the acoustic source may occur within 30 km of the coast.

(ii) From November 1 through April 30, no use of the acoustic source may occur within an area bounded by the greater of three distinct components at any location: (1) A 47-km wide coastal strip throughout the entire Mid- and South Atlantic OCS planning areas; (2) Unit 2 of designated critical habitat for the North Atlantic right whale, buffered by 10 km; and (3) the designated southeastern seasonal management area (SMA) for the North Atlantic right whale, buffered by 10 km. North Atlantic right whale dynamic management areas (DMA; buffered by 10 km) are also closed to use of the acoustic source when in effect. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

(iii) No use of the acoustic source may occur within the areas designated by coordinates in Table 3 during applicable time periods. Area #1 is in effect from June 1 through August 31. Areas #2–4 are in effect year-round. Area #5 is in effect from July 1 through September 30.

(j) Vessel Strike Avoidance

(i) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

(ii) All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).

(iii) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

(iv) All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

(A) While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

(B) If a whale is spotted in the path of a vessel or within 100 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 100 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

(v) All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

(A) The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(vi) All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(k) All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 × 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 × 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) Vessel names (source vessel and other vessels associated with survey) and call signs

(ii) PSO names and affiliations

(iii) Dates of departures and returns to port with port name

(iv) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(v) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(vi) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vii) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(viii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

(ix) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

(x) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

(xi) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting

(B) Time when first and last heard

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

(a) Spectrum shall submit monthly interim reports detailing the amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken,'' using correction factors given in Table 19.

(b) Spectrum shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(c) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, Spectrum shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Name and type of vessel involved;

(C) Vessel's speed during and leading up to the incident;

(D) Description of the incident;

(E) Status of all sound source use in the 24 hours preceding the incident;

(F) Water depth;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(H) Description of all marine mammal observations in the 24 hours preceding the incident;

(I) Species identification or description of the animal(s) involved;

(J) Fate of the animal(s); and

(K) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take.

NMFS will work with Spectrum to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Spectrum may not resume their activities until notified by NMFS.

(ii) In the event that Spectrum discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), Spectrum shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(c)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with Spectrum to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that Spectrum discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Spectrum shall report the incident to NMFS within 24 hours of the discovery. Spectrum shall provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals. TGS

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in TGS's IHA application and using an array with characteristics specified in the application, in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas.

3. General Conditions

(a) A copy of this IHA must be in the possession of TGS, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of TGS operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11.

(c) The taking by serious injury or death of any of the species listed in Table 11 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) TGS shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations. TGS shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and protected species monitoring team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations.

(e) During use of the acoustic source, if the source vessel encounters any marine mammal species that are not listed in Table 11, then the acoustic source must be shut down to avoid unauthorized take.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) TGS must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One ''experienced'' visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that ''experienced'' PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience to the maximum extent practicable.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to acoustic PSOs, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(vi) Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, shall be relayed to the source vessel and to the PSO team.

(vii) During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation

(i) The source vessel must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(iv) Survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding small delphinoids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Buffer Zone and Exclusion Zone—The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown of the acoustic source. PSOs must monitor the buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance).

(f) Ramp-up—A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. Ramp-up may not be initiated if any marine mammal is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs would monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone. Ramp-up may occur at times of poor visibility if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups shall be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(g) Shutdown Requirements

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

(ii) Upon completion of ramp-up, if a marine mammal appears within, enters, or appears on a course to enter the exclusion zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the acoustic PSO is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement.

(A) This shutdown requirement is waived for dolphins of the following genera: *Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(iii) Shutdown of the acoustic source is required upon observation of a right whale or fin whale at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

(v) Shutdown of the acoustic source is required upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel.

(vi) Shutdown of the acoustic source is required upon observation (visual or acoustic) of a beaked whale or *Kogia* spp. at any distance.

(vii) Shutdown of the acoustic source is required upon observation of an aggregation (*i.e.,* six or more animals) of marine mammals of any species that does not appear to be traveling.

(viii) Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdown due to observation of a right whale), a 30-minute clearance period must be observed following the last observation of the animal(s).

(ix) If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. For any longer shutdown, pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(h) Miscellaneous Protocols

(i) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

(i) Closure Areas

(i) No use of the acoustic source may occur within 30 km of the coast.

(ii) From November 1 through April 30, no use of the acoustic source may occur within an area bounded by the greater of three distinct components at any location: (1) A 47-km wide coastal strip throughout the entire Mid- and South Atlantic OCS planning areas; (2) Unit 2 of designated critical habitat for the North Atlantic right whale, buffered by 10 km; and (3) the designated southeastern seasonal management area (SMA) for the North Atlantic right whale, buffered by 10 km. North Atlantic right whale dynamic management areas (DMA; buffered by 10 km) are also closed to use of the acoustic source when in effect. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

(iii) No use of the acoustic source may occur within the areas designated by coordinates in Table 3 during applicable time periods. Area #1 is in effect from June 1 through August 31. Areas #2–4 are in effect year-round. Area #5 is in effect from July 1 through September 30.

(j) Vessel Strike Avoidance

(i) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

(ii) All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).

(iii) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

(iv) All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

(A) While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

(B) If a whale is spotted in the path of a vessel or within 100 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 100 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

(v) All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

(A) The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(vi) All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(k) All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) Vessel names (source vessel and other vessels associated with survey) and call signs

(ii) PSO names and affiliations

(iii) Dates of departures and returns to port with port name

(iv) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(v) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(vi) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vii) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(viii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

(ix) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

(x) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

(xi) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting

(B) Time when first and last heard

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

(a) TGS shall submit monthly interim reports detailing the amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken,'' using correction factors given in Table 19.

(b) TGS shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(c) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, TGS shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Name and type of vessel involved;

(C) Vessel's speed during and leading up to the incident;

(D) Description of the incident;

(E) Status of all sound source use in the 24 hours preceding the incident;

(F) Water depth;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(H) Description of all marine mammal observations in the 24 hours preceding the incident;

(I) Species identification or description of the animal(s) involved;

(J) Fate of the animal(s); and

(K) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with TGS to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. TGS may not resume their activities until notified by NMFS.

(ii) In the event that TGS discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), TGS shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(c)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with TGS to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that TGS discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), TGS shall report the incident to NMFS within 24 hours of the discovery. TGS shall provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

ION

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in ION's IHA application and using an array with characteristics specified in the application, in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas.

3. General Conditions

(a) A copy of this IHA must be in the possession of ION, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of ION operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11.

(c) The taking by serious injury or death of any of the species listed in Table 11 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) ION shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations. ION shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and protected species monitoring team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations.

(e) During use of the acoustic source, if the source vessel encounters any marine mammal species that are not listed in Table 11, then the acoustic source must be shut down to avoid unauthorized take.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) ION must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One ''experienced'' visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that ''experienced'' PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience to the maximum extent practicable.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to acoustic PSOs, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(vi) Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, shall be relayed to the source vessel and to the PSO team.

(vii) During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation

(i) The source vessel must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(iv) Survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding small delphinoids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Buffer Zone and Exclusion Zone—The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown of the acoustic source. PSOs must monitor the buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance).

(f) Ramp-up—A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. Ramp-up may not be initiated if any marine mammal is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs would monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone. Ramp-up may occur at times of poor visibility if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups shall be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(g) Shutdown Requirements

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

(ii) Upon completion of ramp-up, if a marine mammal appears within, enters, or appears on a course to enter the exclusion zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the acoustic PSO is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement.

(A) This shutdown requirement is waived for dolphins of the following genera: *Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(iii) Shutdown of the acoustic source is required upon observation of a right whale at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

(v) Shutdown of the acoustic source is required upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel.

(vi) Shutdown of the acoustic source is required upon observation (visual or acoustic) of a beaked whale or *Kogia* spp. at any distance.

(vii) Shutdown of the acoustic source is required upon observation of an aggregation (*i.e.,* six or more animals) of marine mammals of any species that does not appear to be traveling.

(viii) Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdown due to observation of a right whale), a 30-minute clearance period must be observed following the last observation of the animal(s).

(ix) If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. For any longer shutdown, pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(h) Miscellaneous Protocols

(i) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

(i) Closure Areas

(i) No use of the acoustic source may occur within 30 km of the coast.

(ii) From November 1 through April 30, no use of the acoustic source may occur within an area bounded by the greater of three distinct components at any location: (1) A 47-km wide coastal strip throughout the entire Mid- and South Atlantic OCS planning areas; (2) Unit 2 of designated critical habitat for the North Atlantic right whale, buffered by 10 km; and (3) the designated southeastern seasonal management area (SMA) for the North Atlantic right whale, buffered by 10 km. North Atlantic right whale dynamic management areas (DMA; buffered by 10 km) are also closed to use of the acoustic source when in effect. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

(iii) No use of the acoustic source may occur within Areas #2–5, as designated by coordinates in Table 3 during applicable time periods. Areas #2–4 are in effect year-round. Area #5 is in effect from July 1 through September 30.

(j) Vessel Strike Avoidance

(i) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

(ii) All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).

(iii) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

(iv) All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

(A) While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

(B) If a whale is spotted in the path of a vessel or within 100 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 100 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

(v) All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

(A) The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(vi) All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(k) All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) Vessel names (source vessel and other vessels associated with survey) and call signs

(ii) PSO names and affiliations

(iii) Dates of departures and returns to port with port name

(iv) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(v) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(vi) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vii) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(viii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

(ix) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

(x) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

(xi) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting

(B) Time when first and last heard

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

(a) ION shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize data collected as required under condition 5(d) of this IHA and must provide corrected numbers of marine mammals ''taken,'' using correction factors given in Table 19. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(b) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, ION shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Name and type of vessel involved;

(C) Vessel's speed during and leading up to the incident;

(D) Description of the incident;

(E) Status of all sound source use in the 24 hours preceding the incident;

(F) Water depth;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(H) Description of all marine mammal observations in the 24 hours preceding the incident;

(I) Species identification or description of the animal(s) involved;

(J) Fate of the animal(s); and

(K) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with ION to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. ION may not resume their activities until notified by NMFS.

(ii) In the event that ION discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), ION shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(b)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with ION to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that ION discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ION shall report the incident to NMFS within 24 hours of the discovery. ION shall provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

Western

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in Western's IHA application and using an array with characteristics specified in the application, in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas.

3. General Conditions

(a) A copy of this IHA must be in the possession of Western, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of Western operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11.

(c) The taking by serious injury or death of any of the species listed in Table 11 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) Western shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations. Western shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and protected species monitoring team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations.

(e) During use of the acoustic source, if the source vessel encounters any marine mammal species that are not listed in Table 11, then the acoustic source must be shut down to avoid unauthorized take.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) Western must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One ''experienced'' visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that ''experienced'' PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience to the maximum extent practicable.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to acoustic PSOs, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(vi) Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, shall be relayed to the source vessel and to the PSO team.

(vii) During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation

(i) The source vessel must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(iv) Survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding small delphinoids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Buffer Zone and Exclusion Zone—The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown of the acoustic source. PSOs must monitor the buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance).

(f) Ramp-up—A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. Ramp-up may not be initiated if any marine mammal is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs would monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone. Ramp-up may occur at times of poor visibility if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups shall be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(g) Shutdown Requirements

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

(ii) Upon completion of ramp-up, if a marine mammal appears within, enters, or appears on a course to enter the exclusion zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the acoustic PSO is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement.

(A) This shutdown requirement is waived for dolphins of the following genera: *Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(iii) Shutdown of the acoustic source is required upon observation of a right whale at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

(v) Shutdown of the acoustic source is required upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel.

(vi) Shutdown of the acoustic source is required upon observation (visual or acoustic) of a beaked whale or *Kogia* spp. at any distance.

(vii) Shutdown of the acoustic source is required upon observation of an aggregation (*i.e.,* six or more animals) of marine mammals of any species that does not appear to be traveling.

(viii) Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdown due to observation of a right whale), a 30-minute clearance period must be observed following the last observation of the animal(s).

(ix) If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. For any longer shutdown, pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(h) Miscellaneous Protocols

(i) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

(i) Closure Areas

(i) No use of the acoustic source may occur within 30 km of the coast.

(ii) From November 1 through April 30, no use of the acoustic source may occur within an area bounded by the greater of three distinct components at any location: (1) A 47-km wide coastal strip throughout the entire Mid- and South Atlantic OCS planning areas; (2) Unit 2 of designated critical habitat for the North Atlantic right whale, buffered by 10 km; and (3) the designated southeastern seasonal management area (SMA) for the North Atlantic right whale, buffered by 10 km. North Atlantic right whale dynamic management areas (DMA; buffered by 10 km) are also closed to use of the acoustic source when in effect. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

(iii) No use of the acoustic source may occur within the areas designated by coordinates in Table 3 during applicable time periods. Area #1 is in effect from June 1 through August 31. Areas #2–4 are in effect year-round. Area #5 is in effect from July 1 through September 30.

(j) Vessel Strike Avoidance

(i) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

(ii) All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).

(iii) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

(iv) All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

(A) While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

(B) If a whale is spotted in the path of a vessel or within 100 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 100 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

(v) All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

(A) The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(vi) All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(k) All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) Vessel names (source vessel and other vessels associated with survey) and call signs

(ii) PSO names and affiliations

(iii) Dates of departures and returns to port with port name

(iv) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(v) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(vi) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vii) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(viii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

(ix) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

(x) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

(xi) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting

(B) Time when first and last heard

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

(a) Western shall submit monthly interim reports detailing the amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken,'' using correction factors given in Table 19.

(b) Western shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(c) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, Western shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Name and type of vessel involved;

(C) Vessel's speed during and leading up to the incident;

(D) Description of the incident;

(E) Status of all sound source use in the 24 hours preceding the incident;

(F) Water depth;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(H) Description of all marine mammal observations in the 24 hours preceding the incident;

(I) Species identification or description of the animal(s) involved;

(J) Fate of the animal(s); and

(K) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with Western to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Western may not resume their activities until notified by NMFS.

(ii) In the event that Western discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), Western shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(c)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with Western to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that Western discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), Western shall report the incident to NMFS within 24 hours of the discovery. Western shall provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if

NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

CGG

1. This incidental harassment authorization (IHA) is valid for a period of one year from the date of issuance.

2. This IHA is valid only for marine geophysical survey activity, as specified in CGG's IHA application and using an array with characteristics specified in the application, in the Atlantic Ocean within BOEM's Mid- and South Atlantic OCS planning areas.

3. General Conditions

(a) A copy of this IHA must be in the possession of CGG, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of CGG operating under the authority of this IHA.

(b) The species authorized for taking are listed in Table 11. The taking, by Level A and Level B harassment only, is limited to the species and numbers listed in Table 11.

(c) The taking by serious injury or death of any of the species listed in Table 11 or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA. Any taking exceeding the authorized amounts listed in Table 11 is prohibited and may result in the modification, suspension, or revocation of this IHA.

(d) CGG shall ensure that the vessel operator and other relevant vessel personnel are briefed on all responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements prior to the start of survey activity, and when relevant new personnel join the survey operations. CGG shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and protected species monitoring team participate in a joint onboard briefing led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, marine mammal monitoring protocol, operational procedures, and IHA requirements are clearly understood. This briefing must be repeated when relevant new personnel join the survey operations.

(e) During use of the acoustic source, if the source vessel encounters any marine mammal species that are not listed in Table 11, then the acoustic source must be shut down to avoid unauthorized take.

4. Mitigation Requirements

The holder of this Authorization is required to implement the following mitigation measures:

(a) CGG must use independent, dedicated, trained PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course.

(b) At least two PSOs must have a minimum of 90 days at-sea experience working as PSOs during a deep penetration seismic survey, with no more than eighteen months elapsed since the conclusion of the at-sea experience. At least one of these must have relevant experience as a visual PSO and at least one must have relevant experience as an acoustic PSO. One ''experienced'' visual PSO shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. The lead PSO shall devise the duty schedule such that ''experienced'' PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience to the maximum extent practicable.

(c) Visual Observation

(i) During survey operations (*e.g.,* any day on which use of the acoustic source is planned to occur; whenever the acoustic source is in the water, whether activated or not), a minimum of two PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.,* from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.

(ii) Visual monitoring must begin not less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

(iii) Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.

(iv) Visual PSOs shall communicate all observations to acoustic PSOs, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(v) Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(vi) Any observations of marine mammals by crew members aboard any vessel associated with the survey, including chase vessels, shall be relayed to the source vessel and to the PSO team.

(vii) During good conditions (*e.g.,* daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

(d) Acoustic Observation

(i) The source vessel must use a towed passive acoustic monitoring (PAM) system, which must be monitored beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.

(ii) Acoustic PSOs shall communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

(iii) Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours observation per 24-hour period.

(iv) Survey activity may continue for brief periods of time when the PAM system malfunctions or is damaged. Activity may continue for 30 minutes without PAM while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring under the following conditions:

(A) Daylight hours and sea state is less than or equal to BSS 4;

(B) No marine mammals (excluding small delphinoids) detected solely by PAM in the exclusion zone in the previous two hours;

(C) NMFS is notified via email as soon as practicable with the time and location in which operations began without an active PAM system; and

(D) Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

(e) Buffer Zone and Exclusion Zone—The PSOs shall establish and monitor a 500-m exclusion zone and a 1,000-m buffer zone. These zones shall be based upon radial distance from any element of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source, occurrence of marine mammals within the buffer zone (but outside the exclusion zone) shall be communicated to the operator to prepare for the potential shutdown of the acoustic source. PSOs must monitor the buffer zone for a minimum of 30 minutes prior to ramp-up (*i.e.,* pre-clearance).

(f) Ramp-up—A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. Ramp-up may not be initiated if any marine mammal is within the designated buffer zone. If a marine mammal is observed within the buffer zone during the pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the buffer zone or until an additional time period has elapsed with no further sightings (*i.e.,* 15 minutes for small odontocetes and 30 minutes for all other species). PSOs would monitor the buffer zone during ramp-up, and ramp-up must cease and the source shut down upon observation of marine mammals within or approaching the buffer zone. Ramp-up may occur at times of poor visibility if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances. The operator must notify a designated PSO of the planned start of ramp-up as agreed-upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up. A designated PSO must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Total duration should be approximately 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed. Ramp-ups shall be scheduled so as to minimize the time spent with source activated prior to reaching the designated run-in.

(g) Shutdown Requirements

(i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source (visual PSOs on duty should be in agreement on the need for delay or shutdown before requiring such action). When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs and initiation of dialogue as necessary. When there is certainty regarding the need for mitigation action on the basis of either visual or acoustic detection alone, the relevant PSO(s) must call for such action immediately. When only the acoustic PSO is on duty and a detection is made, if there is uncertainty regarding species identification or distance to the vocalizing animal(s), the acoustic source must be shut down as a precaution.

(ii) Upon completion of ramp-up, if a marine mammal appears within, enters, or appears on a course to enter the exclusion zone, the acoustic source must be shut down (*i.e.,* power to the acoustic source must be immediately turned off). If a marine mammal is detected acoustically, the acoustic source must be shut down, unless the acoustic PSO is confident that the animal detected is outside the exclusion zone or that the detected species is not subject to the shutdown requirement.

(A) This shutdown requirement is waived for dolphins of the following genera: *Steno, Tursiops, Stenella, Delphinus, Lagenodelphis,* and *Lagenorhynchus.* The shutdown waiver only applies if the animals are traveling, including approaching the vessel. If animals are stationary and the source vessel approaches the animals, the shutdown requirement applies. If there is uncertainty regarding identification (*i.e.,* whether the observed animal(s) belongs to the group described above) or whether the animals are traveling, shutdown must be implemented.

(iii) Shutdown of the acoustic source is required upon observation of a right whale at any distance.

(iv) Shutdown of the acoustic source is required upon observation of a whale (*i.e.,* sperm whale or any baleen whale) with calf at any distance, with ''calf'' defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult.

(v) Shutdown of the acoustic source is required upon observation of a diving sperm whale at any distance centered on the forward track of the source vessel.

(vi) Shutdown of the acoustic source is required upon observation (visual or acoustic) of a beaked whale or *Kogia* spp. at any distance.

(vii) Shutdown of the acoustic source is required upon observation of an aggregation (*i.e.,* six or more animals) of marine mammals of any species that does not appear to be traveling.

(viii) Upon implementation of shutdown, the source may be reactivated after the animal(s) has been observed exiting the exclusion zone or following a 30-minute clearance period with no further observation of the animal(s). Where there is no relevant zone (*e.g.,* shutdown due to observation of a right whale), a 30-minute clearance period must be observed following the last observation of the animal(s).

(ix) If the acoustic source is shut down for reasons other than mitigation (*e.g.,* mechanical difficulty) for brief periods (*i.e.,* less than 30 minutes), it may be activated again without ramp-up if PSOs have maintained constant visual and acoustic observation and no visual detections of any marine mammal have occurred within the exclusion zone and no acoustic detections have occurred. For any longer shutdown, pre-clearance watch and ramp-up are required. For any shutdown at night or in periods of poor visibility (*e.g.,* BSS 4 or greater), ramp-up is required but if the shutdown period was brief and constant observation maintained, pre-clearance watch is not required.

(h) Miscellaneous Protocols

(i) The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided.

Notified operational capacity (not including redundant backup airguns) must not be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be noticed to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

(ii) Testing of the acoustic source involving all elements requires normal mitigation protocols (*e.g.,* ramp-up). Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance.

(i) Closure Areas

(i) No use of the acoustic source may occur within 30 km of the coast.

(ii) From November 1 through April 30, no use of the acoustic source may occur within an area bounded by the greater of three distinct components at any location: (1) A 47-km wide coastal strip throughout the entire Mid- and South Atlantic OCS planning areas; (2) Unit 2 of designated critical habitat for the North Atlantic right whale, buffered by 10 km; and (3) the designated southeastern seasonal management area (SMA) for the North Atlantic right whale, buffered by 10 km. North Atlantic right whale dynamic management areas (DMA; buffered by 10 km) are also closed to use of the acoustic source when in effect. It is the responsibility of the survey operators to monitor appropriate media and to be aware of designated DMAs.

(iii) No use of the acoustic source may occur within Areas #2–5, as designated by coordinates in Table 3 during applicable time periods. Areas #2–4 are in effect year-round. Area #5 is in effect from July 1 through September 30.

(j) Vessel Strike Avoidance

(i) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down or stop their vessel or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel according to the parameters stated below. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members, but crew members responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena and broadly to identify a marine mammal as a right whale, other whale, or other marine mammal (*i.e.,* non-whale cetacean or pinniped). In this context, ''other whales'' includes sperm whales and all baleen whales other than right whales.

(ii) All vessels, regardless of size, must observe the 10 kn speed restriction in DMAs, the Mid-Atlantic SMA (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).

(iii) Vessel speeds must also be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near a vessel.

(iv) All vessels must maintain a minimum separation distance of 500 m from right whales. If a whale is observed but cannot be confirmed as a species other than a right whale, the vessel operator must assume that it is a right whale and take appropriate action. The following avoidance measures must be taken if a right whale is within 500 m of any vessel:

(A) While underway, the vessel operator must steer a course away from the whale at 10 kn or less until the minimum separation distance has been established.

(B) If a whale is spotted in the path of a vessel or within 100 m of a vessel underway, the operator shall reduce speed and shift engines to neutral. The operator shall re-engage engines only after the whale has moved out of the path of the vessel and is more than 100 m away. If the whale is still within 500 m of the vessel, the vessel must select a course away from the whale's course at a speed of 10 kn or less. This procedure must also be followed if a whale is spotted while a vessel is stationary. Whenever possible, a vessel should remain parallel to the whale's course while maintaining the 500-m distance as it travels, avoiding abrupt changes in direction until the whale is no longer in the area.

(v) All vessels must maintain a minimum separation distance of 100 m from other whales. The following avoidance measures must be taken if a whale other than a right whale is within 100 m of any vessel:

(A) The vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the whale has moved outside of the vessel's path and the minimum separation distance has been established.

(B) If a vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 m.

(vi) All vessels must maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel. If an animal is encountered during transit, a vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course.

(k) All vessels associated with survey activity (*e.g.,* source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring shall be conducted in accordance with the following requirements:

(a) The operator must provide bigeye binoculars (*e.g.,* 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (*i.e.,* Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel. The operator must also provide a night-vision device suited for the marine environment for use during nighttime ramp-up pre-clearance, at the discretion of the PSOs. At minimum, the device should feature automatic brightness and gain control, bright light protection, infrared illumination, and optics suited for low-light situations.

(b) PSOs must also be equipped with reticle binoculars (*e.g.,* 7 x 50) of appropriate quality (*i.e.,* Fujinon or equivalent), GPS, digital single-lens reflex camera of appropriate quality (*i.e.,* Canon or equivalent), compass, and any other tools necessary to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals.

(c) PSO Qualifications

(i) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

(ii) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences and a minimum of 30 semester hours or equivalent in the biological sciences and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver must include written justification. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored marine mammal surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection—PSOs must use standardized data forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source to resume survey. If required mitigation was not implemented, PSOs should submit a description of the circumstances. We require that, at a minimum, the following information be reported:

(i) Vessel names (source vessel and other vessels associated with survey) and call signs

(ii) PSO names and affiliations

(iii) Dates of departures and returns to port with port name

(iv) Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort

(v) Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts

(vi) Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change

(vii) Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions change significantly), including wind speed and direction, Beaufort sea state, Beaufort wind force, swell height, weather conditions, cloud cover, sun glare, and overall visibility to the horizon

(viii) Factors that may be contributing to impaired observations during each PSO shift change or as needed as environmental conditions change (*e.g.,* vessel traffic, equipment malfunctions)

(ix) Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (*i.e.,* pre-ramp-up survey, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.)

(x) If a marine mammal is sighted, the following information should be recorded:

(A) Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform)

(B) PSO who sighted the animal

(C) Time of sighting

(D) Vessel location at time of sighting

(E) Water depth

(F) Direction of vessel's travel (compass direction)

(G) Direction of animal's travel relative to the vessel

(H) Pace of the animal

(I) Estimated distance to the animal and its heading relative to vessel at initial sighting

(J) Identification of the animal (*e.g.,* genus/species, lowest possible taxonomic level, or unidentified); also note the composition of the group if there is a mix of species

(K) Estimated number of animals (high/low/best)

(L) Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.)

(M) Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics)

(N) Detailed behavior observations (*e.g.,* number of blows, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior)

(O) Animal's closest point of approach (CPA) and/or closest distance from the center point of the acoustic source;

(P) Platform activity at time of sighting (*e.g.,* deploying, recovering, testing, shooting, data acquisition, other)

(Q) Description of any actions implemented in response to the sighting (*e.g.,* delays, shutdown, ramp-up, speed or course alteration, etc.); time and location of the action should also be recorded

(xi) If a marine mammal is detected while using the PAM system, the following information should be recorded:

(A) An acoustic encounter identification number, and whether the detection was linked with a visual sighting

(B) Time when first and last heard

(C) Types and nature of sounds heard (*e.g.,* clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal, etc.)

(D) Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), and any other notable information.

6. Reporting

(a) CGG shall submit monthly interim reports detailing the amount and location of line-kms surveyed, all marine mammal observations with closest approach distance, and corrected numbers of marine mammals ''taken,'' using correction factors given in Table 19.

(b) CGG shall submit a draft comprehensive report on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The report must describe all activities conducted and sightings of marine mammals near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all marine mammal sightings (dates, times, locations, activities, associated survey activities). Geospatial data regarding locations where the acoustic source was used must be provided as an ESRI shapefile with all necessary files and appropriate metadata. In addition to the report, all raw observational data shall be made available to NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as required under condition 5(d) of this IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

(c) Reporting injured or dead marine mammals:

(i) In the event that the specified activity clearly causes the take of a marine mammal in a manner not prohibited by this IHA (if issued), such as serious injury or mortality, CGG shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

(A) Time, date, and location (latitude/longitude) of the incident;

(B) Name and type of vessel involved;

(C) Vessel's speed during and leading up to the incident;

(D) Description of the incident;

(E) Status of all sound source use in the 24 hours preceding the incident;

(F) Water depth;

(G) Environmental conditions (*e.g.,* wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(H) Description of all marine mammal observations in the 24 hours preceding the incident;

(I) Species identification or description of the animal(s) involved;

(J) Fate of the animal(s); and

(K) Photographs or video footage of the animal(s).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS will work with CGG to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. CGG may not resume their activities until notified by NMFS.

(ii) In the event that CGG discovers an injured or dead marine mammal, and the lead observer determines that the cause of the injury or death is unknown and the death is relatively recent (*e.g.,* in less than a moderate state of decomposition), CGG shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(c)(1) of this IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with CGG to determine whether additional mitigation measures or modifications to the activities are appropriate.

(iii) In the event that CGG discovers an injured or dead marine mammal, and the lead observer determines that the injury or death is not associated with or related to the specified activities (*e.g.,* previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), CGG shall report the incident to NMFS within 24 hours of the discovery. CGG shall provide photographs or video footage or other documentation of the stranded animal sighting to NMFS.

7. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein, or if NMFS determines the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

Request for Public Comments

We request comment on our analyses, the draft authorizations, and any other aspect of this Notice of Proposed IHAs for the proposed geophysical survey activities. Please include with your comments any supporting data or literature citations to help inform our final decision on the individual requests for MMPA authorization.

Donna S. Wieting,

Director, Office of Protected Resources, National Marine Fisheries Service.

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Biological Opinion on the Bureau of Ocean Energy Management's Issuance of Five Oil and Gas Permits for Geological and Geophysical Seismic Surveys off the Atlantic Coast of the United States, and the National Marine Fisheries Services' Issuance of Associated Incidental Harassment Authorizations: Appendix B

Conditions Applied by CZMA States for Atlantic G&G Applications as of July 6, 2015

TGS (E14-001)

North Carolina

- Where practical, relocate proposed survey transects to avoid South Atlantic Fishery Management Council-designated Habitat Areas of Particular Concern, and important foraging, spawning and refuge areas;
- Time surveys in a manner that avoids potential use conflicts with commercial fishing efforts, offshore fishing tournaments, major recreational fishing areas, and seasonally-focused fishing efforts (a list of the saltwater fishing tournaments planned off North Carolina's coast this fall); and
- Follow the mitigation measures outlined in the Atlantic G&G PEIS.
- Also, the State requires a pre-survey meeting with representatives of the Division of Marine Fisheries and Division of Coastal Management so that precise survey transects and timing can be reviewed and discussed in advance to avoid, minimize, and mitigate any possible impacts or conflicts with the above-referenced resources.

Georgia

- TGS will notify Georgia Dept. of Natural Resources regarding operation of vessels in offshore water adjacent to Georgia.
- Vessels will have functioning AIS (automatic identification system) onboard and operating at all times and vessel names and call signs will be provided to Georgia DNR.
- Airguns will not be discharged within 20 nm of Georgia from April 1 to September 15.
- Airguns will not be discharged within 30 nm of Georgia from November 15 to April 15.

Maryland

- In an effort to avoid user conflicts and socio-economic impacts to Maryland's recreational and commercial fishing operations, TGS shall work with the State to conduct its survey activities on dates that avoid conflict with Maryland fishing tournaments, which will require coordination with the State contact Joe Abe via email or phone with the following information:
    - 30 days prior to TGS's anticipated survey activities offshore of Maryland, with the understanding that this notice is an estimated time period;
    - 14 days prior to TGS's anticipated survey activities offshore of Maryland, with the understanding that this notice is an estimated time period;
    - 3 days prior to TGS's anticipated survey activities offshore of Maryland;
    - The point at which TGS begins survey activities offshore of Maryland; and,
    - When TGS has left the vicinity.
- TGS shall create a communication plan to mitigate any potential user conflicts that includes the following elements:
    - Schedule for reporting on survey operations to the State;
    - Notification of survey operations to a list of stakeholders provided to TGS by the State;
    - Minimum 7 days notice to all stakeholders identified by the State;
    - Compliance with BOEM's guidelines for notice to mariners;

    - TGS' coordination efforts with the Dept. of Defense;
    - Outreach efforts to ports and fishing communities; and
    - Use of Automatic Identification Systems (AIS) for operation vessels, including the survey vessel, chase boat, tenders, and supply vessels.
- TGS shall make every effort to avoid conducting survey activities offshore of Maryland on dates in which Maryland based fishing tournaments are taking place as reflected in NOAA's list of Registered HMS Tournaments.

Delaware

- TGS shall notify the Delaware Department of Natural Resources and Environmental Control Division of Fish and Wildlife Enforcement Agency prior to working in Delaware's mapped recreational fishing use areas and again when leaving the vicinity. The point of contact for Delaware's Chief of Enforcement has been provided to TGS for communication purposes.

GX Technology (E14-003)

Delaware

- GXT shall notify the Delaware Dept. of Natural Resources and Environmental Control Division of Fish and Wildlife Enforcement Agency prior to working in Delaware's mapped recreational fishing use areas and again when leaving the vicinity. The point of contact for Delaware's Chief of Enforcement has been provided to GXT for communication purposes.

Maryland

- GXT will provide the following notifications to the State via email or phone:
    - 30 days prior to GXT's anticipated survey activities offshore Maryland, with the understanding that this notice is an estimated time period;
    - 14 days prior to GXT's anticipated survey activities offshore of Maryland with the understanding that this notice is an estimated time period;
    - 3 days prior GXT's anticipated survey activities offshore of Maryland;
    - The point at which GXT begins survey activities offshore of Maryland; and
    - When GXT has left the vicinity of the waters offshore of Maryland.
- GXT shall create a communication plan to mitigate any potential user conflicts that includes the following elements: Daily, weekly, and monthly reporting of survey operations to the State; Notification of survey operations to a list of stakeholders provided to GXT by the State; Minimum 7 days notice to all stakeholders identified by the State; Compliance with BOEM's guidelines for notice to mariners; GXT's coordination efforts with the Dept. of Defense; Outreach efforts to port and fishing communities; and Use of automatic identification systems (AIS) for operation vessels, including the survey vessel, chase boat, tenders, and supply vessels.
- GXT will make every effort to avoid conducting survey activities offshore of Maryland from July 1 - August 31 and to otherwise avoid dates on with fishing tournaments are taking place.

North Carolina

- GX Technology has a pre-survey meeting with representatives of the State's Division of Coastal Management and Division of Marine Fisheries so that precise survey transects and timing can be reviewed and discussed in advance to avoid, minimize, and mitigate any possible impacts or conflicts with the fisheries off of North Carolina.

<u>South Carolina</u>

- A time area closure must be put in place off the entire South Carolina coast during the height of the most productive time of the sea turtle season, from April to early September. Additionally, GXT, will not conduct seismic survey activities within the 98 foot (30 meter) depth (approximately 40 nautical miles) of the South Carolina coast. GXT will also shorten survey transects that initially bisected the following Marine Protected Areas: Edisto, Georgia, Northern South Carolina, and Charleston Deep and the Georgetown Hole EFH that are located along the Charleston Bump (unique geological feature). GXT agreed to these provisions in an email from Dan Virobik, Supervisor, Operations & Engineering, dated May 11, 2015. This correspondence also included a supporting GIS map referred to as "USAM SPAM" that depicts these areas of exclusion.
- GXT must coordinate and communicate closely with SCDHEC, SCDNR, and the South Atlantic Fishery Management Council (SAFMC) fishery management specialists before and during seismic survey operations to avoid or minimize to the extant practicable effects to important fishery management areas and associated hard bottom habitat.

<u>Georgia</u>

- GXT notify GA DNR regarding operation of vessels in offshore water adjacent to Georgia;
- Both vessels (survey boat and chase boat) will have functioning AIS (automatic identification system) onboard and operating at all times and vessel names and call signs will be provided to GA DNR;
- Airguns will not be discharged within 20 nm of Georgia from April 1 to September 15;
- Airguns will not be discharged within 30 nm of Georgia from November 15 to April 15.

<u>CGG (E14-005)</u>

<u>North Carolina</u>

- Where practical, relocate proposed survey transects to avoid South Atlantic Fishery Management Council-designated Habitat Areas of Particular Concern, and important foraging, spawning and refuge areas;
- Time surveys in a manner that avoids potential use conflicts with commercial fishing efforts, offshore fishing tournaments, major recreational fishing areas, and seasonally-focused fishing efforts; and
- Follow the mitigation measures outlined in the Final Atlantic G&G PEIS that BOEM published.
- Require a pre-survey meeting with representatives of the DMF and DCM so that precise survey transects and timing can be reviewed and discussed in advance to avoid, minimize, and mitigate any possible impacts or conflicts with the above-referenced resources.

<u>South Carolina</u>

- A time area closure must be put in place off the entire South Carolina coast during the height of the most productive time of the sea turtle season, from April to early September within 50 nautical miles. As proposed, CGG will not conduct seismic survey activities within 50 nautical miles of the South Carolina coast. However, CGG has agreedto shorten survey transects that initially bisected the following Marine Protected Areas: Edisto, Georgia, Northern South Carolina, and Charleston Deep and the Georgetown Hole Essential Fish Habitat that are located along the Charleston Bump (unique geological feature). CGG agreed to these provisions in an E-mail from Amber Stookesbury, Environmental Scientist, dated May 20, 2015. This correspondence also included a supporting Geographic Information System map referred to as "Atlantic Planning Area Public Mop SAFMC Areas" that depicts these areas of exclusion.
- CGG must agree to coordinate and communicate closely with SCDHEC, SCDNR and the South Atlantic Fishery Management Council (SAFMC) fishery management specialists before and during seismic survey operations to avoid or minimize to the extent practicable effects to important fishery management areas and associated hard bottom habitat, as agreed to.

Georgia

- CGG will notify Georgia Dept. of Natural Resources regarding operation of vessels in offshore water adjacent to Georgia.
- Vessels will have functioning AIS (automatic identification system) onboard and operating at all times and vessel names and call signs will be provided to Georgia DNR.
- Airguns will not be discharged within 20 nm of Georgia from April 1 to September 15.
- Airguns will not be discharged within 30 nm of Georgia from November 15 to April 15.

Spectrum (E14-006)

Delaware

- Adherence to modifications to the proposed survey track lines as discussed during an April 22, 2015 conference call with Spectrum, and formally submitted in a revised map received on April 30, 2015, which includes:
    - Complete removal of all survey lines within the BOEM designated offshore Delaware administrative boundary;
    - Complete removal of all detailed survey grid lines in Delaware's mapped recreational fishing use areas;
    - Proposed regional survey grid lines shifted to maximize buffer zone around Wilmington and Baltimore offshore canyons;
    - Segment of second northern-most proposed regional survey grid line to be terminated at nexus of first intersecting line.
- Spectrum shall notify the Delaware Dept. of Natural Resources and Environmental Control Division of Fish and Wildlife Enforcement Agency prior to working in Delaware's mapped recreational fishing use areas and again when leaving the vicinity.
- Spectrum, with the input and approval from the DCMP, shall create a communication plan to mitigate any potential user conflicts that will include arrangement of a single point of contact between Spectrum and the State; notification of survey operations to a list of stakeholders; the

minimum number of days notice that must be given to all stakeholders; compliance with BOEM's guidelines for notice to mariners; Spectrum's coordination efforts with DOD; outreach efforts to fishing communities; and the use of automatic identification systems (AIS) for operation vessels, including the survey vessels, chase boats, tenders ,and supply vessels.

Maryland

- In an effort to avoid user conflicts and socio-economic impacts to Maryland's recreational and commercial fishing operations, no seafloor disturbance or seismic testing may take place within 125 nautical miles of Maryland's coast from April 15 - November 15. Additional economically significant fishing tournaments extend beyond the prohibited period, which will require coordination with the State and stakeholders consistent with Condition No. 2 below.
- Spectrum shall notify the State prior to working in offshore waters adjacent to Maryland and again when leaving the vicinity via email or by phone. Spectrum, with the input and approval of the State, shall create a Communications Plan to mitigate any potential user conflicts that include a single point of contact between Spectrum and the State; notification of survey operations to a list of stakeholders; minimum number of days notice that must be given to all stakeholders; compliance with BOEM's guidelines for notice to mariners; Spectrum's coordination efforts with the DOD; outreach efforts to ports and fishing communities; and the use of automatic identification systems (AIS) for operation vessels, including the survey vessel, chase boats, tenders, and supply vessels.

North Carolina

- Spectrum has a pre-survey meeting with representatives of the State's Division of Coastal Management and Division of Marine Fisheries so that precise survey transects and timing can be reviewed and discussed in advance to avoid, minimize, and mitigate any possible impacts or conflicts with the fisheries off of North Carolina.

South Carolina

- A time area closure must be put in place off the entire South Carolina coast during the height of the most productive time of the sea turtle season, from April to early September.
- Additionally, Spectrum will not conduct seismic survey activities within the 98 foot (30 meter) depth (approximately 40 nautical miles) of the South Carolina coast.
- Spectrum will also shorten survey transects that initially bisected the following Marine Protected Areas: Edisto, Georgia, Northern South Carolina, and Charleston Deep and the Georgetown Hole EFH that are located along the Charleston Bump (unique geological feature). Spectrum agreed to these provisions in an email from Richie Miller, President of Spectrum, dated April 29, 2015. This correspondence also included a supporting GIS map referred to as "RevTransects SC" that depicts these areas of exclusion.
- Spectrum must coordinate and communicate closely with SCDHEC, SCDNR, and the South Atlantic Fishery Management Council (SAFMC) fishery management specialists before and during seismic survey operations to avoid or minimize to the extent practicable effects to important fishery management areas and associated hard bottom habitat.

Georgia

- Spectrum notify GA DNR regarding operation of vessels in offshore water adjacent to Georgia.
- Vessels will have functioning AIS (automatic identification system) onboard and operating at all times and vessel names and call signs will be provided to GA DNR.
- Airguns will not be discharged within 20 nm of Georgia from April 1 to September 15.
- Airguns will not be discharged within 30 nm of Georgia from November 15 to April 15.

Spectrum (E14-009)

Delaware

- Adherence to modifications to the proposed survey track lines as discussed during an April 22, 2015 conference call with Spectrum, and formally submitted in a revised map received on April 30, 2015, which includes:
    - Complete removal of all survey lines within the BOEM designated offshore Delaware administrative boundary;
    - Complete removal of all detailed survey grid lines in Delaware's mapped recreational fishing use areas;
    - Proposed regional survey grid lines shifted to maximize buffer zone around Wilmington and Baltimore offshore canyons;
    - Segment of second northern-most proposed regional survey grid line to be terminated at nexus of first intersecting line.
- Spectrum shall notify the Delaware Dept. of Natural Resources and Environmental Control Division of Fish and Wildlife Enforcement Agency prior to working in Delaware's mapped recreational fishing use areas and again when leaving the vicinity.
- Spectrum, with the input and approval from the DCMP, shall create a communication plan to mitigate any potential user conflicts that will include arrangement of a single point of contact between Spectrum and the State; notification of survey operations to a list of stakeholders; the minimum number of days notice that must be given to all stakeholders; compliance with BOEM's guidelines for notice to mariners; Spectrum's coordination efforts with DOD; outreach efforts to fishing communities; and the use of automatic identification systems (AIS) for operation vessels, including the survey vessels, chase boats, tenders ,and supply vessels.

Maryland

- In an effort to avoid user conflicts and socio-economic impacts to Maryland's recreational and commercial fishing operations, no seafloor disturbance or seismic testing may take place within 125 nautical miles of Maryland's coast from April 15 - November 15. Additional economically significant fishing tournaments extend beyond the prohibited period, which will require coordination with the State and stakeholders consistent with Condition No. 2 below.
- Spectrum shall notify the State prior to working in offshore waters adjacent to Maryland and again when leaving the vicinity via email or by phone. Spectrum, with the input and approval of the State, shall create a Communications Plan to mitigate any potential user conflicts that include a single point of contact between Spectrum and the State; notification of survey operations to a list of stakeholders; minimum number of days notice that must be given to all stakeholders;

compliance with BOEM's guidelines for notice to mariners; Spectrum's coordination efforts with the DOD; outreach efforts to ports and fishing communities; and the use of automatic identification systems (AIS) for operation vessels, including the survey vessel, chase boats, tenders, and supply vessels.

North Carolina

- Spectrum has a pre-survey meeting with representatives of the State's Division of Coastal Management and Division of Marine Fisheries so that precise survey transects and timing can be reviewed and discussed in advance to avoid, minimize, and mitigate any possible impacts or conflicts with the fisheries off of North Carolina.

Atlantic Airgun Seismic Survey Protocols

These protocols will be implemented to assist the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement (BSEE), and operators in complying with the Endangered Species Act (ESA; 16 U.S.C. §§ 1531-1544) and Marine Mammal Protection Act (MMPA; 16 U.S.C. §§1361- 1423h). The measures contained herein apply to all surveys associated with the five Oil and Gas (O&G) Permits issued by BOEM to ION, Spectrum, TGS, WesternGeco, and CGG.

Background

The use of airguns and airgun arrays for conducting seismic geophysical acquisition operations may have an impact on marine life. Many marine species are protected under the Endangered Species Act (ESA) and all marine mammals are protected under the Marine Mammal Protection Act (MMPA).

BSEE and BOEM consult jointly with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (FWS) under Section 7 of the ESA to ensure that BOEM or BSEE authorized activities do not jeopardize the continued existence of ESA-listed species nor result in adverse modification of designated critical habitat. Incidental take of ESA-listed species is prohibited except as authorized pursuant to an Incidental Take Statement in a Biological Opinion. Incidental take of ESA listed marine mammals cannot be authorized under the ESA unless also authorized under the MMPA, typically through an Incidental Harassment Authorization (IHA) to an operator for seismic surveys. These protocols are the result of coordination between BOEM, BSEE, and NMFS and are based on: past and present mitigation measures, terms and conditions, and reasonable and prudent measures identified in Biological Opinions issued to the Bureaus; conditions, mitigation, monitoring, and reporting requirements identified in previous Incidental Harassment Authorizations issued to seismic survey operators; and NMFS' technical memorandum on standards for a protected species observer and data management program (Baker et al. 2013). BSEE is tasked as the lead agency for compliance with lessee or operator reporting requirements under current Biological Opinions applicable to both Bureaus. Therefore, while BOEM is issuing these protocols, all observer reports described herein must be submitted to BSEE as well as to NMFS where specified.

In order to protect ESA-listed species and marine mammals during seismic operations, seismic operators are required to use protected species observers (PSO) and follow specific seismic survey protocols when operating. These requirements apply to seismic airgun survey operations, regardless of water depth. These requirements will also be applied as a condition of the approval of applications for geophysical permits. You must demonstrate your compliance with these requirements by submitting to BSEE and NMFS certain reports detailed below.

Definitions

Terms used in these protocols have the following meanings:

1. Protected species means any species listed under the ESA and/or protected by the MMPA. The requirements discussed herein focus on marine mammals and sea turtles since these species are the most likely to be observed during seismic surveys. However, other ESA-listed species (e.g., giant manta rays) are also protected species and observations of them should be reported as detailed below.
2. Airgun means a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.
3. Ramp-up (sometimes referred to as "soft start") means the gradual and systematic increase of emitted sound levels from an airgun array. Ramp-up begins by first activating a single airgun of the smallest volume, followed by doubling the number of active elements in stages until the full complement of an array's airguns are active. Each stage should be approximately the same duration, and the total duration should not be less than approximately 20 minutes.
4. Shutdown of an airgun array means the immediate de-activation of all individual airgun elements of the array.
5. Exclusion zone means the area to be monitored for possible shutdown in order to reduce or eliminate the potential for injury of marine mammals and sea turtles. Two exclusion zones are defined, depending on the species and context. For North Atlantic right whales, beaked whales, *Kogia* spp., sperm and baleen whales with calves, and aggregations of sperm or baleen whales (i.e., six or more), the exclusion zone encompasses the area at and below the sea surface out to a radius of 1.5 kilometers from the edges of the airgun array (0–1,500 meters). Here “calf” is defined as an animal less than two-thirds the body size of an adult observed to be in close association with an adult. For all other marine mammals and sea turtles, the exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters).
6. Buffer zone means an area beyond the exclusion zone to be monitored for the presence of marine mammals and sea turtles that may enter the exclusion zone. During pre-clearance monitoring (i.e., before ramp-up begins), the buffer zone also acts as an extension of the exclusion zone in that observations of marine mammals and sea turtles within the buffer zone would also prevent airgun operations from beginning (i.e. ramp-up). The buffer zone is not applicable for contexts that require an exclusion zone beyond 500 meters. The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 meter exclusion zone, out to a radius of 1000 meters from the edges of the airgun array (500–1,000 meters).
7. Visual monitoring means the use of trained observers (herein referred to as visual PSOs)

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 primarily the exclusion zone, but also the buffer zone. Visual monitoring of the exclusion zones and adjacent waters is intended to establish and, when visual conditions allow, maintain zones around the sound source that are clear of marine mammals and sea turtles, thereby reducing or eliminating the potential for injury. Visual monitoring of the buffer zone is intended to (1) provide additional protection to naïve marine mammals and sea turtles that may be in the area during pre-clearance, and (2) during airgun use, aid in establishing and maintaining the exclusion zone by alerting the visual observer and crew of marine mammals and sea turtles that are outside of, but may approach and enter, the exclusion zone.

8. Acoustic monitoring means the use of trained personnel (sometimes referred to as passive acoustic monitoring [PAM] operators, herein referred to as acoustic PSOs) to operate PAM equipment to acoustically detect the presence of marine mammals. These observers must have successfully completed a passive acoustic observer training program as described below. Acoustic monitoring involves acoustically detecting marine mammals regardless of distance from the source, as localization of animals may not always be possible. Acoustic monitoring is intended to further support visual monitoring in maintaining an exclusion zone around the sound source that is clear of marine mammals, thereby reducing or eliminating the potential for injury. In cases where visual monitoring is not effective (e.g., due to weather, nighttime), acoustic monitoring may be used to allow certain activities to occur, as further detailed below.

General Requirements

1. A copy of a marine mammal IHA and BOEM Permit must be in the possession of the vessel operator, other relevant personnel, the lead PSO (see description below), and any other relevant designees operating under the authority of the IHA and BOEM Permit.
2. The IHA and BOEM Permit holder shall instruct relevant vessel personnel with regard to the authority of the protected species monitoring team, and shall ensure that relevant vessel personnel and the protected species monitoring team participate in a joint onboard briefing (hereafter PSO briefing) led by the vessel operator and lead PSO to ensure that responsibilities, communication procedures, protected species monitoring protocols, operational procedures, and IHA and BOEM Permit requirements are clearly understood. This PSO briefing must be repeated when relevant new personnel join the survey operations before work commences.
3. The acoustic source must be deactivated when not acquiring data or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Notified operational capacity (not including redundant backup airguns) must not

be exceeded during the survey, except where unavoidable for source testing and calibration purposes. All occasions where activated source volume exceeds notified operational capacity must be communicated to the PSO(s) on duty and fully documented. The lead PSO must be granted access to relevant instrumentation documenting acoustic source power and/or operational volume.

Protected Species Observers (PSOs, Visual and Acoustic)

Qualifications

1. The IHA and BOEM Permit holder must use independent, dedicated, trained visual and acoustic PSOs, meaning that the PSOs must be employed by a third-party observer provider, may have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working. PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand. NMFS must review and approve PSO resumes accompanied by a relevant training 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 as well as a document stating successful completion of the course. NMFS shall have one week to approve PSOs from the time that the necessary information is submitted, after which PSOs meeting the minimum requirements shall automatically be considered approved.
2. At least one of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience. One visual PSO with such experience shall be designated as the lead for the entire protected species observation team. The lead shall coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. To the maximum extent practicable, the lead PSO shall devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.
3. PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.

a. PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics. The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver shall be submitted to NMFS and must include written justification. Requests shall be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

Equipment

The IHA and BOEM Permit holder is required to:

1. Provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (i.e., Fujinon or equivalent) solely for PSO use. These shall be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.
2. Work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals and sea turtles. Such equipment, at a minimum, shall include:
    a. Each vessel requiring PAM will include a passive acoustic monitoring system that has been verified and tested by the acoustic PSO that will be using it during the trip for which monitoring is required.
    b. At least one night-vision device suited for the marine environment for use during nighttime pre-clearance and ramp-up that features automatic brightness and gain control, bright light protection, infrared illumination, and/or optics suited for low-light situations (e.g., Exelis PVS-7 night vision goggles; Night Optics D-300 night vision monocular; FLIR M324XP thermal imaging camera or equivalents).
    c. Reticle binoculars (e.g., 7 x 50) of appropriate quality (i.e., Fujinon or equivalent) (at least one per PSO, plus backups)
    d. Global Positioning Units (GPS) (at least one per PSO, plus backups)
    e. Digital single-lens reflex cameras of appropriate quality that capture photographs and video (i.e., Canon or equivalent) (at least one per PSO, plus backups)

f. Compasses (at least one per PSO, plus backups)
g. Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups)
h. Any other tools necessary to adequately perform necessary PSO tasks.

Equipment specified in (a) through (g) above may be provided by an individual PSO, the third-party observer provider, or the IHA and BOEM Permit holder but the latter is responsible for ensuring PSOs have the proper equipment required to perform the duties specified within these protocols.

Visual Monitoring

1. During survey operations (e.g., any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (i.e., from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during nighttime ramp-ups of the airgun array.
2. Visual monitoring of the exclusion and buffer zones must begin no less than 30 minutes prior to ramp-up and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.
3. Visual PSOs shall coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and shall conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
4. PSOs shall establish and monitor applicable exclusion and buffer zones. These zones shall be based upon the radial distance from the edges of the airgun array (rather than being based on the center of the array or around the vessel itself). During use of the acoustic source (i.e., anytime the acoustic source is active, including ramp-up), occurrences of marine mammals (and sea turtles if the voluntary turtle pause is being employed, see below) within the buffer zone (but outside the exclusion zone) should be communicated to the operator to prepare for the potential shutdown (or pause for turtles if being employed) of the acoustic source.
5. Visual PSOs shall immediately communicate all observations to the on duty acoustic PSO(s), including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
6. Any observations of marine mammals and sea turtles by crew members aboard any vessel associated with the survey shall be relayed to the PSO team.
7. During good conditions (e.g., daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs shall conduct observations when the acoustic source is not operating for

comparison of sighting rates and behavior with and without use of the acoustic source and between acquisition periods, to the maximum extent practicable.

8. Visual PSOs may be on watch for a maximum of two consecutive hours followed by a break of at least one hour between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.

Acoustic Monitoring

1. The source vessel must use a towed PAM system, which must be monitored by at a minimum one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.
2. Acoustic PSOs shall immediately communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
3. Acoustic PSOs may be on watch for a maximum of four consecutive hours followed by a break of at least two hours between watches and may conduct a maximum of 12 hours of observation per 24-hour period. Combined observational duties (acoustic and visual but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO.
4. Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional two hours without acoustic monitoring during daylight hours only under the following conditions:
    a. Sea state is less than or equal to BSS 4;
    b. No marine mammals (excluding delphinids) detected solely by PAM in the applicable exclusion zone in the previous two hours;
    c. NMFS and BSEE are notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
    d. Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of four hours in any 24-hour period.

Data Collection

PSOs must use standardized data collection forms, whether hard copy or electronic. PSOs shall record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source. If required mitigation was not implemented, PSOs should record a description of the circumstances. At a minimum, the following information must be recorded within the interim reports:

1. BOEM permit number;
2. Vessel names (source vessel and other vessels associated with survey) and call signs;
3. PSO names and affiliations;
4. Dates of departures and returns to port with port name;
5. Date and participants of PSO briefings (as discussed in General Requirements. 2.)
6. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
7. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
8. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
9. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly), including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
10. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (e.g., vessel traffic, equipment malfunctions);
11. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.); and
12. Upon visual observation of any protected species, the following information:
    a. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
    b. PSO who sighted the animal;
    c. Time of sighting;
    d. Vessel location at time of sighting;
    e. Water depth;
    f. Direction of vessel’s travel (compass direction);
    g. Direction of animal’s travel relative to the vessel;
    h. Pace of the animal;
    i. Estimated distance to the animal and its heading relative to vessel at initial sighting;
    j. Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;

k. Estimated number of animals (high/low/best);
l. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
m. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);
n. Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
o. Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;
p. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
q. Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.

13. If a marine mammal is detected while using the PAM system, the following information should be recorded:
    a. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
    b. Date and time when first and last heard;
    c. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
    d. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

Seismic Survey Protocols

Pre-clearance and Ramp-up

The intent of pre-clearance observation (30 minutes) is to ensure no protected species are observed within the exclusion zones, and buffer zone if applicable (i.e., only when the exclusion zone is equal to 500 meters, see Definitions section, 7. for details on when the buffer zone is not applicable), prior to the beginning of ramp-up. During pre-clearance is the only time observations of protected species in the buffer zone would prevent operations (i.e., the beginning of ramp-up). The intent of ramp-up is to warn protected species of pending seismic operations and to allow sufficient time for those animals to leave the immediate vicinity. A ramp-up procedure, involving a step-wise increase in the number of airguns firing and total array volume until all operational airguns are activated and the full volume is achieved, is required at all times as part of the activation of the acoustic source. All operators must adhere to the following pre-clearance and ramp-up requirements, which are applicable to both marine mammals and sea turtles:

1. The operator must notify a designated PSO of the planned start of ramp-up as agreed upon with the lead PSO; the notification time should not be less than 60 minutes prior to the planned ramp-up in order to allow the PSOs time to monitor the exclusion and buffer zones for 30 minutes prior to the initiation of ramp-up (pre-clearance).
2. Ramp-ups shall be scheduled so as to minimize the time spent with the source activated prior to reaching the designated run-in.
3. One of the PSOs conducting pre-clearance observations must be notified again immediately prior to initiating ramp-up procedures and the operator must receive confirmation from the PSO to proceed.
4. Ramp-up may not be initiated if any marine mammal or sea turtle is within the applicable exclusion or buffer zone. If a marine mammal or sea turtle is observed within the applicable exclusion zone or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zones or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and 30 minutes for all other species including sea turtles).
5. Ramp-up shall begin by activating a single airgun of the smallest volume in the array and shall continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration shall not be less than 20 minutes. The operator must provide information to the PSO documenting that appropriate procedures were followed.
6. PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal or sea turtle within the applicable exclusion zone. Once ramp-up has begun, observations of marine mammals and sea turtles within the buffer zone do not require shutdown, or pause for sea turtles if being employed, but such observation shall be communicated to the operator to prepare for the potential shutdown, or pause for sea turtles if being employed.
7. Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up. Acoustic source activation may only occur at times of poor visibility where operational planning cannot reasonably avoid such circumstances.
8. If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described below in *Shutdown* (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual detections of marine mammals or sea turtles have occurred within the applicable exclusion zone and no acoustic detections of marine mammals have occurred. For any longer shutdown, pre-clearance observation and ramp-

up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.

9. Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

Shutdown

For non-marine mammal protected species, shutdowns are not required. However, for sea turtles, the Permit and IHA holder may employ a voluntary pause during which the visual PSO would request that the operator pause the airgun array for six shots if a sea turtle is observed within the exclusion zone (within 500 meters) during active airgun use, to let the turtle float past the array while it is inactive. For marine mammals, all operators must adhere to the following shutdown requirements:

1. Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown of the acoustic source if a marine mammal is detected within the applicable exclusion zone.
2. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown, and pause commands (optional for sea turtles) are conveyed swiftly while allowing PSOs to maintain watch.
3. When both visual and acoustic PSOs are on duty, all detections must be immediately communicated to the remainder of the on-duty PSO team for potential verification of visual observations by the acoustic PSO or of acoustic detections by visual PSOs.
4. When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up) and (1) a marine mammal appears within or enters the applicable exclusion zone and/or (2) a marine mammal is detected acoustically and localized within the applicable exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the acoustic source must be immediately deactivated and any dispute resolved only following deactivation.
5. The shutdown requirement is waived for dolphins of the following genera: *Steno*, *Tursiops*, *Stenella*, *Delphinus*, *Lagenodelphis*, and *Lagenorhynchus*.
    a. If a small delphinid (individual of the Family Delphinidae, which includes the aforementioned dolphin genera), is acoustically detected and localized within the exclusion zone, no shutdown is required unless the acoustic PSO or a visual PSO confirms the individual to be of a genera other than those listed above, in which case a shutdown is required.
6. If there is uncertainty regarding identification (i.e., whether the observed marine

mammal(s) belongs to one of the delphinid genera for which shutdown is waived or one of the species with a larger exclusion zone), visual PSOs may use best professional judgment in making the decision to call for a shutdown.

7. Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (i.e., animal is not required to fully exit the buffer zone where applicable) or following a 30-minute clearance period with no further observation of the marine mammal(s).

Time-area Restrictions

The BOEM permit and IHA holder shall adhere to any time-area restrictions concerning where and when seismic survey activity may occur as specified in their BOEM permit and IHA. This includes time-area restrictions agreed to as a result of coordination with Delaware, Maryland, North Carolina, South Carolina, and Georgia pursuant to the Coastal Zone Management Act, time-area restrictions required by the conditions of the IHA, and time-area restrictions that resulted from consultation under the National Marine Sanctuaries Act.

Reporting

1. The BOEM permit holder shall submit interim reports (see Data Collection section for details) on the 1st and the 15th of each month to BSEE (protectedspecies@bsee.gov) detailing all protected species observations with closest approach distance.
2. The IHA and BOEM permit holder shall submit a draft comprehensive report to BOEM/BSEE (protectedspecies@boem.gov and protectedspecies@bsee.gov) and NMFS (see IHA for contact information) on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA or BOEM Permit, whichever comes sooner. The report must describe all activities conducted and sightings of protected species near the activities, must provide full documentation of methods, results, and interpretation pertaining to all monitoring, and must summarize the dates and locations of survey operations and all protected species sightings (dates, times, locations, activities, associated survey activities). The draft report shall also include geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa). GIS files shall be provided in ESRI shapefile format and include the UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates shall be referenced to the WGS84 geographic coordinate system. In addition to the report, all raw observational data shall be made available to BOEM/BSEE and NMFS. The report must summarize the information submitted in interim monthly reports as well as additional data collected as described above in *Data*

Collection and the IHA. The draft report must be accompanied by a certification from the lead PSO as to the accuracy of the report, and the lead PSO may submit directly to BOEM/BSEE and NMFS a statement concerning implementation and effectiveness of the required mitigation and monitoring. A final report must be submitted within 30 days following resolution of any comments on the draft report.

3. Reporting injured or dead protected species:
   The IHA and BOEM permit holder must report sightings of any injured or dead aquatic protected species immediately, regardless of the cause of injury or death.

   For injured or dead non-marine mammal aquatic protected species, report incidents to the hotlines listed at https://www.fisheries.noaa.gov/report (phone numbers vary by state). The reporting for non-marine mammal aquatic protected species shall include:

   a. Date and time;
   b. Location (latitude/longitude), and depth;
   c. Relevant weather conditions (e.g., cloud cover, fog, sun glare, etc.);
   d. Name, type, call sign, and speed of the vessel during and leading up to the first sighting;
   e. Description of the sighting including the species identification or a description of the animal(s) involved and its fate if known (e.g., death);
   f. Photographs or video footage of the animal(s) if available.
   g. Status of all sound sources used and a description of all protected species observations in the 24 hours preceding the sighting.

   For reporting dead or injured marine mammals, refer to the reporting requirements specified in the IHA associated with the activity being conducted.

   Following a review of the circumstances of the sighting, BOEM/BSEE will work with NMFS and the Permit and IHA holder to determine the necessary course of action, if any.

References

Baker, K., D. Epperson, G. Gitschlag, H. Goldstein, J. Lewandowski, K. Skrupky, B. Smith, and T. Turk. 2013. National standards for a protected species observer and data management program: A model using geological and geophysical surveys. Technical Memorandum NMFS-OPR-49, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration; Bureau of Ocean Energy Management, U.S. Department of the Interior; Bureau of Safety and Environmental Enforcement, U.S. Department of the Interior, Silver Spring, Maryland.

Atlantic Vessel Strike Avoidance and Injured/Dead Aquatic Protected Species Reporting Protocols

Aquatic Protected Species Identification

Crew and supply vessel personnel should use an Atlantic reference guide that includes identifying information on marine mammals, sea turtles, and other aquatic protected species (e.g., Atlantic sturgeon) that may be encountered in the Atlantic OCS. Vessel operators must comply with the below measures except under extraordinary circumstances when the **safety of the vessel or crew is in doubt or the safety of life at sea is in question**.

Vessel Strike Avoidance

1. Vessel operators and crews must maintain a vigilant watch for all aquatic protected species and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any protected species. A single aquatic protected species at the surface may indicate the presence of submerged animals in the vicinity of the vessel; therefore, precautionary measures should always be exercised. A visual observer aboard the vessel must monitor a vessel strike avoidance zone (species specific distances detailed below) around the vessel according to the parameters stated below, to ensure the potential for strike is minimized. Visual observers monitoring the vessel strike avoidance zone can be either third-party observers or crew members (e.g., captain), but crew members responsible for these duties must be provided sufficient training to distinguish aquatic protected species to broad taxonomic groups, as well as those specific species detailed further below.
2. All vessels, regardless of size, must observe the 10 knot speed restriction in specific areas designated for North Atlantic right whales: any Dynamic Management Areas when in effect, the Mid-Atlantic Seasonal Management Areas (SMA) (from November 1 through April 30), and critical habitat and the Southeast SMA (from November 15 through April 15).
3. Vessel speeds must also be reduced to 10 knots or less when mother/calf pairs, pods, or assemblages of any marine mammal are observed near a vessel.
4. All vessels must maintain a minimum separation distance of 500 meters from North Atlantic right whales. If a whale is observed but cannot be confirmed as a species other than a North Atlantic right whale, the vessel operator must assume that it is a North Atlantic right whale and take appropriate action.
5. All vessels must maintain a minimum separation distance of 100 meters from sperm whales and all other baleen whales (except North Atlantic right whales as noted above).

6. All vessels must, to the maximum extent practicable, attempt to maintain a minimum separation distance of 50 meters from all other aquatic protected species (e.g., sea turtles), with an exception made for those animals that approach the vessel.
7. When aquatic protected species are sighted while a vessel is underway, the vessel should take action as necessary to avoid violating the relevant separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the animal has left the area). If aquatic protected species are sighted within the relevant separation distance, the vessel should reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This does not apply to any vessel towing gear.
8. If a manatee is sighted, vessels associated with the project should operate at "no wake/idle" speeds within that area. Vessels should follow routes of deep water whenever possible. This does not apply to any vessel towing gear.
9. All vessels associated with survey activity (e.g., source vessels, chase vessels, supply vessels) must have a functioning Automatic Identification System (AIS) onboard and operating at all times, regardless of whether AIS would otherwise be required. Vessel names and call signs must be provided to NMFS, and applicants must notify NMFS when survey vessels are operating.

Injured/Dead Protected Species Reporting

Vessel operators must report sightings of any injured or dead aquatic protected species immediately, regardless of whether the injury or death is caused by your vessel. If the injury or death was caused by a collision with your vessel, you must further notify BOEM and BSEE within 24 hours of the strike by email to protectedspecies@boem.gov and protectedspecies@bsee.gov.

For injured or dead non-marine mammal aquatic protected species, report incidents to the hotlines listed at https://www.fisheries.noaa.gov/report (phone numbers vary by state). Reporting for non-marine mammal aquatic protected species shall include:

1. Date and time;
2. Location (latitude/longitude), and depth;
3. Relevant weather conditions (e.g., cloud cover, fog, sun glare, etc.);
4. Name, type, call sign, and speed of the vessel during and leading up to the first sighting;
5. Description of the sighting including the species identification or a description of the animal(s) involved and its fate if known (e.g., death);
6. Photographs or video footage of the animal(s) if available.

For reporting dead or injured marine mammals, refer to the reporting requirements specified in the Incidental Harassment Authorization associated with the activity being conducted.

Following a review of the circumstances of the sighting, BOEM/BSEE will work with NMFS and the Permit and IHA holder to determine the necessary course of action, if any.

OMB Control Number: 1014-0023
OMB Approved Expiration Date: November 30, 2018

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF SAFETY AND ENVIRONMENTAL ENFORCEMENT (BSEE) GULF OF MEXICO OUTER CONTINENTAL SHELF (OCS) REGION

BSEE NTL No. 2015-G03 Effective Date: December 17, 2015

NOTICE TO LESSEES AND OPERATORS (NTL) OF FEDERAL OIL, GAS, AND SULPHUR LEASES AND PIPELINE RIGHT-OF-WAY HOLDERS IN THE OCS, GULF OF MEXICO OCS REGION

Marine Trash and Debris Awareness and Elimination

This NTL is being issued pursuant to 30 CFR 250.103, and 250.300, to provide information on the Offshore Operators Committee (OOC) marine trash and debris awareness training video and slide show. This NTL also provides the mailing and email addresses for submitting annual training reports. This NTL supersedes and replaces NTL No. 2012-G01, effective January 1, 2012, on this subject and applies to all existing and future oil and gas operations in the Gulf of Mexico OCS unless and until expressly superseded.

Background

Marine trash and debris pose a threat to fish, marine mammals, sea turtles, and other marine animals; cause costly delays and repairs for commercial and recreational boating interests; detract from the aesthetic quality of recreational shore fronts; and increase the cost of beach and park maintenance. As oil and gas industry activities expand into deeper waters, the number of species of protected marine animals exposed to marine debris is increasing and now includes the sperm whale, an endangered species, as well as other marine mammals and five species of sea turtles. The discharge of garbage and debris has been the subject of strict laws, such as MARPOL-Annex V and the Marine Debris Act, 33 U.S.C. 1951 *et seq.*, and regulations imposed by various agencies including the United States Coast Guard and the Environmental Protection Agency

Since oil and gas operations in the Gulf of Mexico may contribute to this problem, 30 CFR 250.300(a) and (b)(6) prohibit you from discharging containers and other materials into the marine environment, and 30 CFR 250.300(c) and (d) require you to make durable identification markings on skid-mounted equipment, portable containers, spools or reels, and drums, and to record and report such items when lost overboard to the District Manager through facility daily operations reports. Therefore, in accordance with 30 CFR 250.300(a) and (b)(6), you should exercise special caution when you handle and transport small items and packaging materials, particularly those made of non-biodegradable, environmentally persistent materials such as plastic or glass that can be lost in the marine environment and washed ashore. Increasing your workers' awareness of the problem and emphasizing their responsibilities will help reduce the litter problem further and control the unintended loss of items such as empty buckets, hard hats, shrink wrap, strip lumber and pipe thread protectors.

Marine Trash and Debris Placards

You should continue to post placards that include each of the information text boxes in Appendix 1 of this NTL in prominent places on all fixed and floating production facilities that have sleeping or food preparation capabilities and on mobile drilling units engaged in oil and gas operations in the Gulf of Mexico OCS. Each of the placards depicted, with the language specified, should be displayed on an approximately 5x8 inch format or larger. These signs should be displayed at line-of-sight height at or near boat landings and heliports, in mess areas, and in the recreation or training or orientation area. One or more areas may be omitted if there is insufficient space. These notices should be referenced, and their contents explained, during any initial orientation given on the facility for visitors or occupants. Placards should be sturdy enough to withstand the local environment and should be replaced when damage or wear compromises readability.

Marine Trash and Debris Awareness Training

All of your offshore employees and those contractors actively engaged in your offshore operations (*e.g.*, wireline operators, contract lease operators, and maintenance or construction crews) should complete marine trash and debris awareness training annually.

The training for employees and contractors consists of two parts: (1) viewing a marine trash and debris training video or slide show; and (2) receiving an explanation from management personnel of the lessee or designated lease operator that emphasizes their commitment to the message of this NTL.

You may obtain the marine trash and debris training video, training slide packs, and other marine debris related educational material produced by the OOC, through the OOC website at http://www.theooc.us/marinedebris.html. The video and slides are offered in English and Spanish versions and the video is available as a DVD or VHS tape. The video, slides, and related material may also be downloaded directly from the website.

Marine Trash and Debris Awareness Training and Certification Process

You should continue to develop and use a marine trash and debris awareness training and certification process that reasonably assures that the employees and contractors specified above are in fact trained. Your training process should include the following elements:

1) viewing of either the video or the slide show by the personnel specified above using one of the following methods:
   a) attendance at periodic meetings held for this purpose;
   b) as part of several scheduled training components;
   c) web-based training with email notification; or
   d) training by a third-party contractor;
2) an explanation from the management that conveys the commitment of the company to achieve the objectives of the trash and debris containment requirement;
3) attendance measures (initial and annual); and
4) recordkeeping and availability of records for inspection by BSEE.

By January 31st of each year, you should provide BSEE with an annual report (1-2 pages) signed by a company official that describes your marine trash and debris awareness training process and certifies that the training process has been followed for the previous calendar year. A sample annual report/certification letter is available at the OOC website above. You should send the report by email to marinedebris@bsee.gov.

In lieu of emailing the report, you may send a printed copy to:

Bureau of Safety and Environmental Enforcement
Gulf of Mexico OCS Region
Office of Environmental Compliance (MS GE466)
1201 Elmwood Park Blvd.
New Orleans, Louisiana 70123

Guidance Document Statement

BSEE issues NTLs as guidance documents in accordance with 30 CFR 250.103 to clarify or provide more detail about certain BSEE regulatory requirements and to outline the information you must provide in your various submittals. Under that authority, this NTL sets forth a policy on, and an interpretation of, a regulatory requirement that provides a clear and consistent approach to complying with the requirements.

Paperwork Reduction Act of 1995 (PRA) Statement

The PRA (44 U.S.C. 3501 et seq.) requires us to inform you that we collect the information described in this NTL to ensure that you conduct operations in a manner that will not jeopardize threatened or endangered species or destroy or adversely modify critical habitat that has been designated for those species. We protect all proprietary information submitted according to the Freedom of Information Act and 30 CFR 250.197. An agency may not conduct or sponsor a collection of information unless it displays a currently valid Office of Management and Budget (OMB) Control Number. We estimate the hour burden to be 1 hour for the training video request; 3 hours relating to recordkeeping; and 1.5 hours for each annual report and certification. The placard postings are exempt from the PRA requirements. Direct comments regarding the burden or any other aspect of this information collection to the BSEE Information Collection Clearance Officer; 45600 Woodland Rd., Sterling, VA 20166.

In addition, this NTL refers to information collection requirements under 30 CFR 250, Subpart C. OMB has approved all of the information collection requirements in these regulations and assigned OMB Control Number 1014-0023.

Contact

Submit any questions regarding this NTL by e-mail to: marinedebris@bsee.gov.

Lars Herbst
Regional Director
Gulf of Mexico OCS Region

Appendix 1

Marine Debris Placards

WHAT IS MARINE DEBRIS?

Marine debris is any object or fragment of wood, metal, glass, rubber, plastic, cloth, paper or any other man-made item or material that is lost or discarded in the marine environment. Marine debris may be intentionally dumped, accidentally dropped, or indirectly deposited. Whatever the source, marine debris is a direct result of human activities on land and at sea. Depending upon its composition, marine debris may sink to the seafloor, drift in the water column, or float on the surface of the sea. Certain debris, such as plastics, can persist for hundreds of years in the marine environment without decomposing.

WARNING!

YOUR ACTIONS MAY SUBJECT YOU TO SEVERE LEGAL CONSEQUENCES!

The disposal and/or discharge of any solid waste anywhere in the marine environment (other than ground-up food particles) is strictly prohibited by U.S. Coast Guard and Environmental Protection Agency regulations. THIS INCLUDES MATERIALS OR DEBRIS ACCIDENTALLY LOST OVERBOARD.

The disposal of equipment, cables, chains, containers or other materials into offshore waters is prohibited by the Bureau of Safety and Environmental Enforcement (30 CFR 250.300(b)(6)). THIS INCLUDES MATERIALS OR DEBRIS ACCIDENTALLY LOST OVERBOARD.

ATTENTION!

MARINE DEBRIS MAY CAUSE SEVERE ECOLOGICAL DAMAGE!

Marine debris discarded or lost from offshore and coastal sources may injure or kill fish, marine mammals, sea turtles, seabirds and other wildlife.

Thousands of marine animals, including marine mammals, sea turtles and seabirds, die every year from entanglement in fishing line, strapping bands, discarded ropes and nets and plastic six-pack rings. Additionally, unknown numbers of marine animals die each year from internal injury, intestinal blockage and starvation as a result of ingesting marine debris.

Marine debris fouls boat propellers and clogs water intake ports on engines thereby endangering the safety of fishermen and boaters and resulting in heavy loss of time and money.

Marine debris detracts from the aesthetic quality of recreational beaches and shorelines and increases the cost of park and beach maintenance.

ATTENTION!

SECURE ALL LOOSE ARTICLES!

NOAA Fisheries now expects petroleum industry personnel to pick up and recover any articles lost overboard from boats and offshore structures as safety conditions permit. Additionally, 30 CFR 250.300 (d) requires recording and reporting items lost overboard to the District Manager through facility daily operations reports.

Protect marine animals, as well as your valuable time and money, by doing the following to prevent accidental loss of these items:

Properly securing all materials, equipment, and personal belongings. Articles such as hardhats, life vests, sunglasses, cigarette lighters, parts bags, buckets, shrink wrap, strip lumber, and pipe thread protectors become marine debris when lost overboard.

Making sure that all trash receptacles have tight fitting lids and that the lids are used.

Providing and using secure cigarette butt containers. Cigarette butts are one of the most common forms of marine debris. Many cigarette butts contain some form of plastic and do not decompose in the ocean. Cigarette butts pose a major threat to marine wildlife as they resemble food and cause gut blockages and starvation when ingested.

Do your part to eliminate marine debris. Encourage others to be responsible about marine debris by making suggestions to secure potential marine debris on your boat or structure or by participating in a beach cleanup.