National Marine Fisheries Service
Endangered Species Act Section 7
Biological Opinion

Title:	Biological Opinion on a National Science Foundation-funded seismic survey by the Scripps Institution of Oceanography, and Issuance of an Incidental Harassment Authorization pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA) by the Permits and Conservation Division, National Marine Fisheries Service
Consultation Conducted By:	Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, United States (U.S.) Department of Commerce
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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 National Marine Fisheries Service (NMFS) for threatened or endangered species (ESA-listed), or designated critical habitat that may be affected by the action that are under NMFS's 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's 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 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 an incidental take is expected, 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.

The action agencies for this consultation are the National Science Foundation (NSF) and the NMFS' Permits and Conservation Division. Two federal actions are considered in this biological opinion. The first is the NSF-funded collaborative research project, led by the Scripps Institution of Oceanography, to conduct a seismic survey in the northwest Atlantic Ocean in June and July 2018. The second is the NMFS' Permits and Conservation Division's proposal to issue an incidental harassment authorization (IHA) authorizing non-lethal "takes" from Level B harassment (as defined by the Marine Mammal Protection Act [MMPA]) of marine mammals incidental to the planned seismic survey, pursuant to section 101 (a)(5)(D) of the MMPA, 16 U.S.C. § 1371 (a)(5)(D).

This consultation, biological opinion, and incidental take statement, were completed in accordance with section 7(a)(2) of the statute (16 U.S.C. 1536 (a)(2)), associated implementing regulations (50 C.F.R. §§401-16), and agency policy and guidance and was conducted by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division (hereafter referred to as "we"). This biological opinion (opinion) and incidental take statement were prepared by NMFS Office of Protected Resources Endangered Species Act Interagency Cooperation Division in accordance with section 7(b) of the ESA and implementing regulations at 50 C.F.R. Part402.

This document represents the NMFS's opinion on the effects of the proposed actions on endangered and threatened whales, sea turtles, and fishes and designated critical habitat for those species. A complete record of this consultation is on file at the NMFS Office of Protected Resources in Silver Spring, Maryland.

1.1 Background

The NSF is proposing to fund a seismic survey in the northwest Atlantic Ocean to take place on or about June 14, 2018, to July 17, 2018. In conjunction with this action, the NMFS's Permits and Conservation Division would issue an IHA under the MMPA for marine mammal takes that could occur during the NSF-sponsored seismic survey. Both the NSF and the Permits and Conservation Division have conducted similar actions in the past that have been the subject of ESA section 7 consultations.

1.2 Consultation History

On December 18, 2017, the NMFS' ESA Interagency Cooperation Division received a request for formal consultation pursuant to section 7 of the ESA from the NSF to incidentally harass marine mammal and sea turtle species during the seismic survey. On the same date, the NMFS' Permits and Conservation Division received an application from the Scripps Institution of Oceanography to incidentally harass marine mammal species pursuant to the MMPA during the proposed seismic survey.

The Permits and Conservation Division had several questions on the IHA request. The Permits and Conservation Division and the ESA Interagency Cooperation Division also had questions on the draft environmental assessment regarding sources of marine mammal density information and requested additional information. As a result, the NSF submitted revised versions of the draft environmental analysis on March 15, 2018. NMFS deemed the information sufficient to initiate ESA section 7 consultation with the NSF on the same day.

On April 23, 2018, the NMFS' ESA Interagency Cooperation Division received a request for formal consultation under section 7 of the ESA from the NMFS' Permits and Conservation Division for issuance of the MMPA IHA. NMFS deemed the information sufficient to initiate ESA section 7 consultation with the Permits and Conservation Division on the same day. This opinion is based on information provided in the:

- MMPA IHA application.
- Draft public notice of proposed IHA.
- Draft Environmental Assessment prepared pursuant to the National Environmental Policy Act.
- Monitoring reports from similar activities.
- Published and unpublished scientific information on endangered and threatened species and their surrogates.

- Scientific and commercial information such as reports from government agencies and the peer-reviewed literature.
- Biological opinions on similar activities.

2 THE ASSESSMENT FRAMEWORK

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to ensure 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). An ESA section 7 assessment involves the following steps:

Description of the Proposed Action (Section 3): we describe the proposed action and those aspects (or stressors) of the proposed action that may have direct or indirect effects on the physical, chemical, and biotic environment.

Action Area (Section 4): we describe the proposed action and those aspects (or stressors) of the proposed action that may have direct or indirect effects on the physical, chemical, and biotic environment. We identify any interrelated and interdependent actions and describe the action area within the spatial extent of the stressors from those actions.

Interrelated and Interdependent Actions (Section 5): we identify any 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 use, apart from the action under consideration.

Potential Stressors (Section 6): we identify the stressors that could occur as a result of the proposed action and affect ESA-listed species and designated critical habitat.

Species and Designated Critical Habitat Not Considered Further in the Opinion (Section 7): we identify those resources will either not be affected or are not likely to be adversely affected.

Species and Critical Habitat Likely to be Adversely Affected (Section 8): we identify the ESA-listed species and designated critical habitat that are likely to co-occur with the stressors identified in Section 6.

Status of Species and Designated Critical Habitat (Section 9): we identify the status of ESA-listed species and designated critical habitat that are likely to occur in the action area.

*Environmental Baseline (*Section 10): 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, impacts of state or private actions that are contemporaneous with the consultation in process.

Effects of the Action (Section 11): we identify the number, age (or life stage), and sex of ESA-listed individuals that are likely to be exposed to the stressors and the populations or subpopulations to which those individuals belong. We also consider whether the action "may affect" designated critical habitat. We evaluate the available evidence to determine how individuals of the ESA-listed species are likely to respond given their probable exposure and consider how 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 risk analysis also considers the impacts of the proposed action on the essential biological features and conservation value of designated critical habitat.

Integration and Synthesis (Section 12): we integrate the analyses in the opinion to formulate the agency's biological opinion as to whether the action is likely to appreciably reduce the likelihood of survival and recovery of an ESA-listed species in the wild or reduce the conservation value of designated critical habitat.

Cumulative Effects (Section 13): 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.

Conclusion (Section 14): 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 essential habitat features 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 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(h).

In addition, we include an incidental take statement (Section 15) that specifies the impact of the take, 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 that may be implemented by action agency (Section 16). 50 C.F.R. §402.14(j). Finally, we identify the circumstances in which reinitiation of consultation is required (Section 17). 50 C.F.R. §402.16.

To comply with our obligation to use the best scientific and commercial data available, we collected information identified through searches of Google Scholar and 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:

- Information submitted by the Permits and Conservation Division and the National Science Foundation
- Government reports (including NMFS biological opinions and stock assessment reports
- NOAA technical memos
- Peer-reviewed scientific literature.

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.

Two federal actions were evaluated in this opinion. The first is the NSF's proposal to fund the research vessel *Atlantis,* operated by the Scripps Institution of Oceanography, to conduct a seismic survey in the northwest Atlantic Ocean in June and July 2018. The second is the NMFS'

Permits and Conservation Division proposal to issue an IHA authorizing non-lethal "takes" from Level B harassment pursuant to section 101 (a)(5)(D) of the MMPA. The information presented here is based primarily upon the Environmental Assessment provided by NSF as part of the initiation package.

3.1 Proposed Activities: National Science Foundation

The NSF proposes to fund the use of the research vessel *Atlantis*, operated by the Woods Hole Oceanographic Institution, and the use of a multi-channel seismic system operated by the Scripps Institution of Oceanography, to conduct a seismic survey in the northwest Atlantic Ocean. An array of two operational air guns will be deployed as an energy source. In addition, a multibeam echosounder and sub-bottom profiler will continuously operate from the *Atlantis* during the entire research collection portion of the cruise, but not during transit to and from the survey areas.

The proposed survey would examine climate evolution, as recorded in the ocean, along the Western North Atlantic Meridional and Paleodepth Transect. Six sites would be surveyed to support information for future research in the area and to provide sedimentary records for comparison to those in the Pacific. In addition, the multi-channel seismic profiling would provide seismic images of changing sediment distributions from deep-water production changes.

3.1.1 Survey Overview and Project Objectives

The survey would begin on or about June 14, 2018, with the *Atlantis* departing St. George's, Bermuda. The *Atlantis* would return to Woods Hole, Massachusetts, on or about July 17, 2018. The survey would last for a total of 33 days. There would be approximately 3 days of transit from Bermuda to the first survey area, and about 5 days of transit from the last survey site to Woods Hole. Seismic operations would take place for an estimated 25 days, barring any logistical or operational issues.

The proposed seismic survey would take place in waters over 1,000 meters deep. There are six survey sites, each 40 nautical miles square, with 240 nautical miles of tracklines in the grid. A grid could have up to ten intersecting survey lines. Part of the purpose of the proposed action is to collect data on these survey sites to help make decisions for future research. Each of these six sites would be surveyed twice, at different speeds and using different air gun configurations. The first pass in a survey grid (referred to as the "reconnaissance grid") would be used to identify the optimum orientation and length of seismic lines needed for the second pass through the grid. The reconnaissance grid would be surveyed at 8 knots, using a 200-meter streamer, with two air guns positioned 8-meters apart.

During the second pass (called the "data acquisition grid"), higher-quality data would be collected within the grid using information from the first pass. The data acquisition grid would be surveyed at 5 knots, using a 600-meter streamer, with two air guns positioned 2-meters apart. The air gun tow depth for both passes would be the same: 2 to 4-meters.

Ultimately, these data would be used to better identify sites for future research. Currently, most of the existing data for these sites are low-resolution, single-channel, analog seismic data from 30 to 40 years ago.

In addition to the six survey sites, the proposed action would include survey lines connecting the survey sites. The connecting survey lines would be surveyed at 8 knots, with the air guns towed 8-meters apart using a 200-meter streamer. The purpose of this portion of the seismic survey would be to collect multi-channel seismic profiles to replace existing, poor-quality data.

3.1.2 Source Vessel Specifications

The *Atlantis* will tow the air gun array along predetermined lines and within survey grids at the six survey sites (Figure 3). The operating speed during seismic acquisition for survey grid data collections is 9-kilometers (km) per hour (5 knots). During the reconnaissance grids, the *Atlantis* will travel at 15-km per hour (8 knots). When not towing seismic survey gear, the *Atlantis* typically cruises at 22 to 23-km per hour (12 to 12.5 knots). The *Atlantis* also serves as the platform from which protected species' visual observers (observers) watch for animals.

3.1.3 Air Gun Description

The air gun configuration includes two active 45-cubic inch (in^3) generator-injector air guns; with their source, output directed downward (Table 1). As discussed above, there will be different air gun configurations for each of the different portions of the project. The air guns will be towed 21 meters behind the vessel, 2 or 8-meters apart, at a depth of 2 to 4-meters and fire every 8 to 10 seconds, or every 25 or 50 meters travelled. A 200 or 600-meter streamer would be towed along with the air gun array to receive the reflected signals and transfer the data to the on-board processing system. During firing, a brief (approximately 0.1 second) pulse of sound will be emitted. This signal attenuates as it moves away from the source, decreasing in amplitude, but also increasing in signal duration. Air guns will operate continually during the survey period (i.e., while surveying the tracklines) except for unscheduled shutdowns.

Because the actual source originates from the pair of air guns, rather than a single point source, the highest sound levels measurable at any location in the water are less than the nominal sound source level emitted by the air guns. In addition, the effective source level for sound spreading in near-horizontal directions will be substantially lower than the nominal source level applicable to downward propagation because of the directional nature of sound from the air gun array.

Table 1. Source array specifications for the proposed survey.

Source array specifications	
Energy source	Two inline 45-in^3 air guns 2-meters or 8-meters apart
Source output (downward)-2 air gun array 2-meter gun separation	Zero to peak = 230.9 dB re 1 μPa-m Peak to peak = 236.7 dB re 1 μPa-m

Source array specifications	
Source output (downward)-2 air gun array 8-meter gun separation	Zero to peak = 231.4 dB re 1 µPa-m Peak to peak = 237.4 dB re 1 µPa-m
Air discharge volume	~ 90-in^3
Dominant frequency components	0 to 188 hertz
Tow depth	3-meters

3.1.4 Multibeam Echosounder and Sub-bottom Profiler

Along with air gun operations, additional acoustical data acquisition systems will operate during the surveys from the *Atlantis.* The multibeam echosounder as well as sub-bottom profiler systems will map the ocean floor during the cruise. These sound sources will operate from the *Atlantis* simultaneously with the air gun array, as well as when the air guns are shutdown. They will not be in use while the vessel is in transit.

The sub-bottom profiler (Knudsen 3260) is a hull-mounted sonar system that operates at 3.5 to 210 kilohertz (kHz) with a single 27° bottom-directed beam. The nominal power output is 10 kilowatts, but the actual maximum radiated power is 3 kilowatts or 222 decibels (dB) re 1 µPa·m (decibels at 1 micro Pascal-meter). The ping duration is up to 64 milliseconds, and the ping interval is 1 second. A common mode of operation is to broadcast five pings at 1-second intervals.

The multibeam echosounder (Kongsberg EM 122) is also a hull-mounted system operating at 12 kHz. The beam width is 1 or 2° fore and aft and 150° perpendicular to the ship's line of travel. The maximum source level is 242 dB re 1 µPa·m$_{\text{rms}}$ (decibels at 1 micro Pascal-meter root mean squared). Each "ping" consists of four or eight successive fan-shaped transmissions, each 2 to 15 milliseconds in duration and each ensonifying a sector that extends 1° fore and aft. Four or eight successive transmissions span an overall cross-track angular extent of about 150°.

3.1.5 Proposed Exclusion Zones

The NSF identifies in its draft Environmental Assessment that the Scripps Institution of Oceanography will implement exclusion zones around the *Atlantis* to minimize any potential adverse effects of air gun sound on MMPA and ESA-listed species. These zones are areas where seismic air guns would be powered down or shut down to reduce exposure of marine mammals and sea turtles to acoustic impacts. These exclusion zones are based upon modeled sound levels at various distances from the *Atlantis,* described below.

The LGL Limited, (the environmental research associates who prepared the draft Environmental Assessment) used modeling by Lamont-Doherty Earth Observatory to predict received sound levels, in relation to distance and direction from two 45-in^3 Generator-Injector (GI) air guns in deep water (Figure 1 and Figure 2). In 2003, empirical data concerning 190, 180, and 160 dB re 1 µPa$_{\text{rms}}$ distances were acquired during the acoustic calibration study of the R/V *Ewing*'s air gun array in a variety of configurations in the northern Gulf of Mexico (Tolstoy 2004) and in 2007 to 2009 aboard the R/V *Langseth* (Diebold 2010; Tolstoy et al. 2009). As a two-air gun array at the same tow and water depths were not measured, the estimates provided here were extrapolated from other results, using conservative assumptions. Results of the propagation measurements (Tolstoy et al. 2009) showed that radii around the air guns for various received levels varied with water depth. However, the depth of the array was different in the Gulf of Mexico calibration study (6-meters) from in the proposed survey (4-meters). Because propagation varies with array depth, correction factors have been applied to the distances reported by Tolstoy et al. (2009).

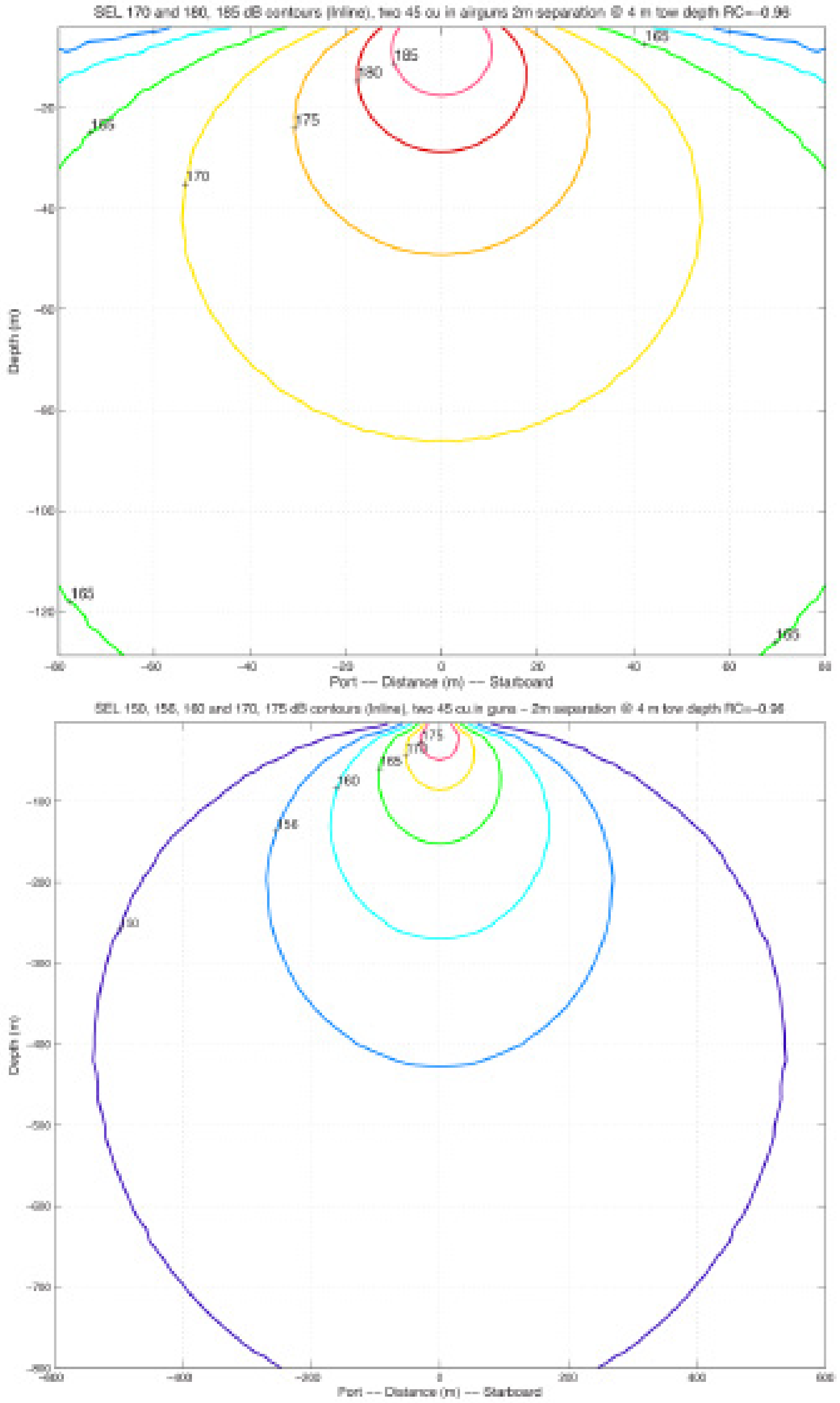
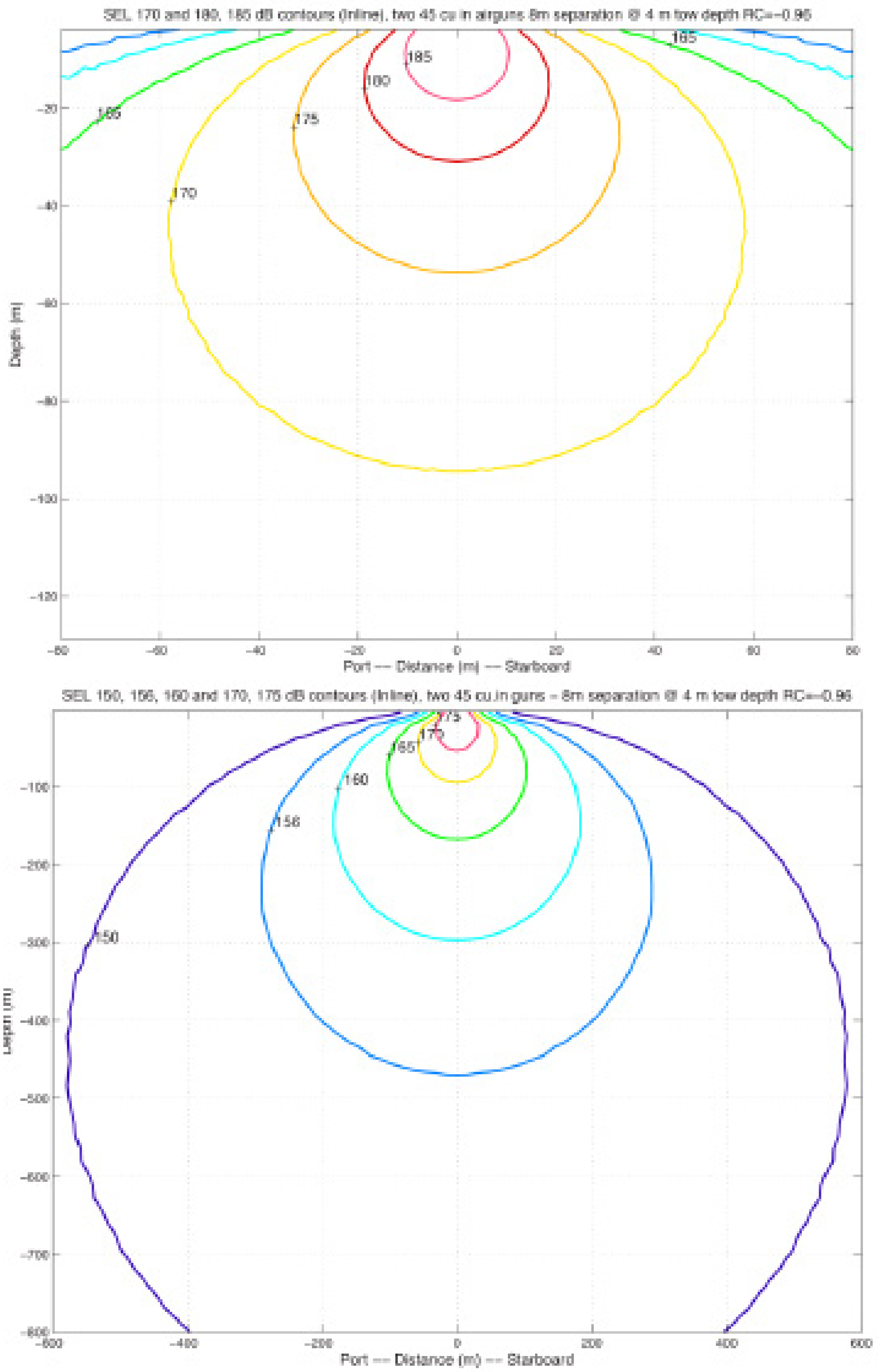


Figure 1. Modeled received sound exposure levels from two 45-cubic inch (in^3) generator-injector air guns at 2-meter separation, operating in deep water at a 4-meter tow depth. Received root mean squared (rms) levels sound pressure levels are likely about 10 decibels higher.



SEL 170 and 180, 185 dB contours (Inline), two 45 cu in airguns 8m separation @ 4 m tow depth RC=−0.96

SEL 150, 156, 160 and 170, 175 dB contours (Inline), two 45 cu.in guns - 8m separation @ 4 m tow depth RC=−0.96

Figure 2. Modeled received sound exposure levels from two 45-cubic inch (in^3) generator-injector air guns at 8-meter separation, operating in deep water at a 4-meter tow depth. Received root mean squared (rms) levels sound pressure levels are likely about 10 decibels higher.

The National Science Foundation and Lamont-Doherty Earth Observatory applied acoustic thresholds to determine at what point during exposure to the airgun arrays marine mammals are "harassed," based on definitions provide in the MMPA (16 U.S.C. §1362(18)(a)). The National Science Foundation and Lamont-Doherty Earth Observatory concluded that ESA-listed marine mammals would be exposed to the airgun array during the proposed seismic survey activities. These acoustic thresholds were also used to develop radii for buffer and exclusion zones around the sound source to determine appropriate mitigation measures. Table 2 shows the distances at which root mean squared sound levels are expected to be received from the air gun array. These thresholds are used to develop radii for exclusion zones around a sound source and the necessary power-down or shut-down criteria to limit marine mammals and sea turtles' exposure to harmful levels of sound (NOAA 2016).The 160 dB re 1 μPa_{rms} distance is the safety criteria as specified by NMFS (1995) for cetaceans, as required by the NMFS during other Lamont-Doherty Earth Observatory seismic projects (Holst and Smultea 2008b; Holst et al. 2005a; Holst 2008; Holt 2008b; Smultea et al. 2004). It is also the threshold at which the NMFS' Permits and Conservation Division is proposing to issue authorization for incidental take of marine mammals. The 175 dB isopleth represents our best understanding of the threshold at which sea turtles exhibit behavioral responses to seismic air guns (Mccauley et al. 2000c) Popper et al. (2014a).

Table 2. Predicted distances to which sound levels ≥160 and 175 dB re 1 μParms could be received from the two-air gun, 90-cubic inch (in^3) array towed at 2 and 8-meter separation.

Air gun Configuration	Predicted rms radii (meters)	
	160 dB	175 dB
Two air guns at 2-meter gun separation	539	91
Two air guns at 8-meter gun separation	578	103

3.2 Proposed Activities: NMFS Permits and Conservation Division's Incidental Harassment Authorization

The NMFS' Permits and Conservation Division is proposing to issue an IHA authorizing non-lethal "takes" from Level B harassment of marine mammals incidental to the planned seismic survey. The IHA will be valid for a period of one year from the date of issuance. The IHA will authorize the incidental harassment of the following ESA-listed marine mammal species: blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*), sei whales (*Balaenoptera borealis*), and sperm whales (*Physeter macrocephalus*). The IHA will also authorize incidental take for other marine mammals listed under the Marine Mammal Protection Act. The proposed IHA identifies requirements that Scripps Institution of Oceanography must comply with as part of its authorization that are likely to be protective of ESA-listed species. These requirements are contained in Appendix A.

4 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 proposed action would take place in the northwest Atlantic Ocean, between approximately 33.5° and 53.5° North, and 37° and 49° West. The seismic survey would take place entirely in international waters (Figure 3). The survey would take place in water depths greater than 1,000 meters. The action area would also include the area covered by the *Atlantis* while transiting from its port in Bermuda to the survey area, and its return to Woods Hole at the conclusion of the survey.

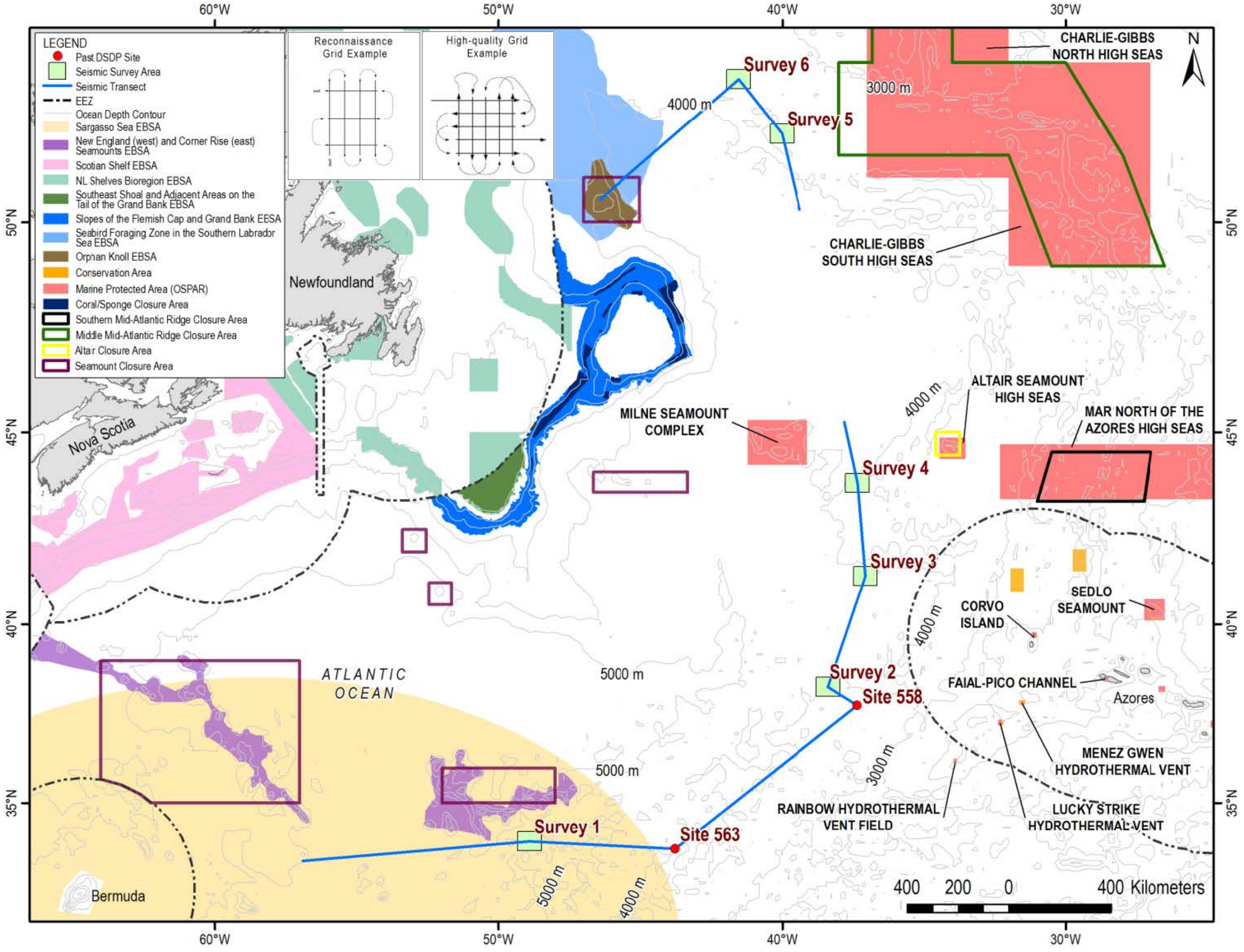


Figure 3. Map of the action area

5 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 transit associated with the seismic activities that would be conducted the IHA 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.

6 POTENTIAL STRESSORS

There are several potential stressors that we expect to occur because of the proposed action. These include those associated with vessel activity (e.g., pollution by oil or fuel leakage, vessel strikes, and acoustic interference from engine noise) and research activity (e.g., entanglement in the towed hydrophone streamer and the sound produced by the air guns, sub-bottom profiler, and multibeam echosounder). These stressors are evaluated in detail in Section 10.

7 SPECIES AND 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 beneficial. The ESA-listed species and designated critical habitat potentially occurring within the action area that may be affected by the proposed action are listed in Table 3, along with their regulatory status. The designated critical habitat that occurs within the action area and may be affected by the proposed action is identified in Table 3.

Table 3. Endangered Species Act listed resources that may be affected by the proposed actions.

Species	ESA Status	Critical Habitat	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
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	76 FR 43985
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 73 FR 12024	81 FR 4837	70 FR 32293 08/2004

Species	**ESA Status**	**Critical Habitat**	**Recovery Plan**
Sea Turtles			
Loggerhead Turtle (*Caretta caretta*) – Northeast Atlantic Ocean DPS	E – 76 FR 58868	-- --	-- --
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic Ocean DPS	T – 76 FR 58868	79 FR 39856	74 FR 2995 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 01/2009 – Northwest Atlantic
Leatherback turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710	63 FR 28359 and 10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Green Turtle (*Chelonia mydas*) – North Atlantic DPS	T – 81 FR 20057	63 FR 46693	FR Not Available 10/1991 – U.S. Atlantic
Hawksbill Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693	63 FR 28359 and 57 FR 38818 08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico
Kemp's Ridley Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	09/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 09/2011
Fishes			
Giant Manta Ray (*Manta birostris*)	T – 83 FR 2916	-- --	-- --
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	T – 83 FR 4153	-- --	-- --
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	-- --	-- --

7.1 Species Not Likely to be Adversely Affected

NMFS uses two criteria to identify the ESA-listed species 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. 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 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 Elasmobranchs (Giant Manta Ray and Oceanic Whitetip Shark)

The action area encompasses the range of ESA-listed elasmobranchs. Both oceanic whitetip sharks (*Carcharhinus longimanus*) and giant manta rays (*Manta birostris*) are listed as threatened throughout their range.

Oceanic whitetip sharks and giant manta rays might be exposed to the stressors associated with vessel activity (e.g., strike, noise, and visual disturbance), or entanglement in the seismic gear during operation. Both species occupy tropical and subtropical oceanic waters. Oceanic whitetip sharks can be found at the ocean surface, (28.2 percent of their time at depths less than 25 meters) but frequently stay between 25.5 and 50 meters deep or more (Carlson and Gulak 2012; Young 2016). Giant manta rays are found at depths less than ten meters during the day (Miller

2016). We expect that giant manta rays and whitetip oceanic sharks will, for the most part, be at depths where there will be minimal risk of vessel strike, entanglement in gear, or exposure to noise. The vessel's passage past a giant manta ray or oceanic whitetip shark would be brief and not likely to be significant in affecting any individual's ability to feed, reproduce, or avoid predators. Because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor is insignificant. Therefore, we conclude that acoustic interference from engine noise is not likely to adversely affect oceanic whitetip sharks and giant manta rays.

ESA-listed elasmobranchs may also be exposed to stressors associated with fuel or oil leaks. The potential for fuel or oil leakages is extremely unlikely. 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. In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. Because the potential for fuel or oil leakage is extremely unlikely to occur, we find that the risk from this potential stressor to any ESA-listed elasmobranch is discountable. We conclude that fuel leaks are not likely to adversely affect oceanic whitetip sharks and giant manta rays.

ESA-listed elasmobranchs (which include giant manta rays and oceanic whitetip sharks) may occur in the action area and be affected by sound fields generated by air guns and echosounders.

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 hertz (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 air gun array if exposed. However, the duration and intensity of low-frequency acoustic stressors 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 air gun array signals. Myrberg et al. (1978) reported that silky shark withdrew 10 meters 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. (2014b) 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. 2014b). Popper et al. (2014b) 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 air guns 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 expect the most likely response of ESA-listed elasmobranchs 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. If these behavioral reactions were to occur, we would not expect them to result in impacts such as reduced foraging.

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 and these species will not be considered further in this opinion. We conclude that the sound generated by the seismic survey activities will not adversely affect oceanic whitetip sharks and giant manta rays.

7.1.2 Nassau Grouper

Nassau grouper (*Epinephelus striatus*), listed as threatened under the ESA, is a fish distributed throughout the Caribbean, and occurs in Bermuda. The *Atlantis* will depart from its port in Bermuda, meaning that Nassau grouper could be exposed to the stressors associated with vessel activity (i.e., vessel strike, disturbance from engine noise, pollution by oil leakage). Seismic activities will not take place in Bermuda, and will not happen until the *Atlantis* gets to the first survey grid, over 400-km away from Bermuda and well outside of the area where we expect Nassau grouper. As such, Nassau grouper will not be exposed to the stressors associated with seismic activities that include noise and the potential for entanglement in research gear. Therefore, we believe the seismic survey portion of the action will have no effect on Nassau grouper.

Nassau grouper typically associate with coral reefs, with juveniles occupying shallow reef habitat, mangrove embayments, and seagrass beds, and adults occupying deep reefs (NMFS 2013b). The vessel in use for the proposed action would be too large to enter shallow waters, and Nassau grouper typically remain near the bottom rather than swimming near the water surface, thus interactions with the vessel would be extremely unlikely. In addition, because the vessel will transit in deeper waters, we do not anticipate any accidental groundings or other impacts to areas that provide habitat to various life stages of Nassau grouper. Adult Nassau grouper congregate in the water column during spawning aggregations, which are now rare due to the depletion of the populations of Nassau grouper because of fishing. We do not anticipate the proposed action to affect spawning aggregations because these peak in January/February and the research cruise will take place in June and July. Therefore, effects from vessel operation associated with the proposed action on Nassau grouper would be discountable. Nassau grouper will not be adversely affected by the stressors associated with vessel operation.

The vessel’s passage past Nassau grouper would be brief and not likely to be significant in affecting any individual’s ability to feed, reproduce, or avoid predators. Because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor is insignificant.

Therefore, we conclude that acoustic interference from engine noise is not likely to adversely affect Nassau grouper. We conclude that the species will not be adversely affected.

The potential for discharges via fuel or oil leakages is extremely unlikely. 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. Research vessels used in NSF-funded seismic surveys have spill-prevention plans, which would allow a rapid response to a spill in the event one occurred (NSF 2011). In the event that a leak should occur, the amount of fuel and oil onboard the research vessel is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. Because the potential for fuel or oil leakage is extremely unlikely to occur, we find that the risk from discharges associated with vessel operations to Nassau grouper is discountable, and it will not be adversely affected.

7.1.3 North Atlantic Right Whales

North Atlantic right whales (*Eubalaena glacialis*) are typically found in coastal or shelf waters. The proposed seismic activities will take place in the Northwest Atlantic Ocean, over the Mid-Atlantic Ridge, in waters over 1,000 meters deep, over 1,000 km away from shore. Seismic activities will not take place near the North Atlantic right whale foraging areas. The proposed action will take place in June and July, when we expect North Atlantic right whales to be on the summer foraging grounds in Cape Cod Bay, Stellwagen Bank, Georges Bank, and the Great South Channel off the coasts of Maine, New Hampshire, and Massachusetts. A recent evaluation of passive acoustic recordings from 2004 to 2014 show some North Atlantic right whales in the waters between Iceland and Greenland in summer, near 60° North latitude (Davis et al. 2017). The northernmost seismic survey area is at about 53° North latitude. Therefore, because the seismic activities will not occur where we expect North Atlantic right whales to be, they will not be exposed to the stressors associated with seismic activities. We conclude the seismic survey will have no effect on North Atlantic right whales.

The proposed action will include vessel transit through waters where North Atlantic right whales might occur when the *Atlantis* is returning to port in Woods Hole, Massachusetts. North Atlantic right whales could be exposed to the stressors associated with vessel activity, including:

- Pollution by oil or fuel leakage.
- Vessel strike.
- Acoustic interference from engine noise.

As discussed previously, the potential for fuel or oil leakages is extremely unlikely. Research vessels used in NSF-funded seismic surveys have spill-prevention plans, which would allow a rapid response to a spill in the event one occurred (NSF 2011). 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. In the event that a leak should occur, the amount of fuel and oil onboard the *Atlantis* is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. Because the potential for fuel or oil leakage is extremely unlikely to occur, we find that the risk to North Atlantic right whales from this potential stressor is discountable, and it will not be adversely affected.

We are not aware of a ship-strike by a seismic survey vessel. The generally slow movement of the *Atlantis* during most of its travels reduces the risk of ship-strike (Hauser and Holst 2009; Holst 2009; Holst 2010; Holst and Smultea 2008a). The *Atlantis* has traveled hundreds of thousands of kilometers without a reported vessel strike. We generally expect that marine mammals would move away from or parallel to the *Atlantis,* avoiding the vessel. Protected species observers would also be on watch during transit, and could alert the crew to the presence of a North Atlantic right whale so they could avoid it. Therefore, we have concluded the potential for vessel strike is extremely low and we find the risk from this potential stressor to North Atlantic right whale is discountable. We conclude that North Atlantic right whales will not be adversely affected vessel strike.

We expect that the *Atlantis* will add to the local noise environment in its operating area due to the propulsion and other noise characteristics of the vessel's machinery. This contribution is likely small in the overall regional sound field. The *Atlantis'* passage past a whale would be brief and not likely to impact an individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of whales to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Lusseau 2006). In addition, the *Atlantis* will be traveling at slow speeds, reducing the amount of noise produced by the propulsion system (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Therefore, because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor to North Atlantic right whale is insignificant, and it will not be adversely affected.

7.1.4 Kemp's Ridley Sea Turtles

Kemp's ridley sea turtles (*Lepidochelys kempii*) nest primarily in the western Gulf of Mexico. Kemp's ridley sea turtles undergo coastal migrations along the U.S. coast, and can be found as far north as the Grand Banks near Newfoundland, Canada. They are occasionally sighted in the northeast Atlantic Ocean, near the Azores and in the Mediterranean Sea, but these might be misidentified loggerhead sea turtles (NMFS 2015a). After hatching, Kemp's ridley sea turtles use ocean currents like the Gulf Stream or the anticyclonic Mexican Current to travel into the ocean, where they remain in the pelagic environment until they are about 2 years old. A particle simulation to predict distribution of oceanic-phase Kemp's ridleys predicted that the highest abundance of hatchlings would be found in the Gulf of Mexico (i.e., west of 85° West), with comparatively fewer going into the Atlantic Ocean (Putman et al. 2013). Witherington et al. (2012) found no Kemp's ridley juveniles or post-hatchlings while sampling *Sargassum* mats in the Atlantic Ocean off Florida.

Kemp's ridley juveniles and sub-adults are mostly found in waters up to 50 meters deep (Coleman et al. 2017), and inter-nesting females occupied waters 14 to 19 meters deep, 6 to 11 km from shore (Shaver et al. 2017). There are no known nesting sites or foraging areas within the action area. Known foraging sites for adult females in the Gulf of Mexico are in waters less than 68 meters deep and an average of 33 km from shore (Shaver et al. 2013). The proposed seismic activity will take place in waters greater than 1,000 meters deep.

Based on the above assessment, we believe that Kemp's ridley sea turtles of any life stage are unlikely to be exposed to the stressors associated with seismic activities, because we do not expect them to be in the area while the seismic surveys are occurring. Therefore, we believe the seismic survey will have no effect on Kemp's ridley sea turtles.

Kemp's ridley sea turtles may be present in the nearshore coastal environments while the *Atlantis* is departing or returning from port and thus exposed to the stressors associated with vessel activity.

Similar to the reasons discussed above for other species, the potential for effects from fuel or oil leakages is extremely unlikely. We expect that the vessel's spill response plan, plus the rapid corrective action by the crew, would prevent Kemp's ridley sea turtles from being exposed to fuel or oil leakages. We find that the risks from these potential stressors are discountable. We are not aware of a sea turtle ship-strike by a seismic survey vessel. Protected species observers would be on watch during vessel transit, and be able to alert the crew to the presence of a sea turtle, and allow the ship to avoid striking it. We consider the potential effects from vessel strike to be discountable. Any noise introduced to the local environment during vessel transit would be a small contribution to the overall sound field. Because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor is insignificant, and Kemp's ridley sea turtles will not be adversely affected.

8 SPECIES LIKELY TO BE ADVERSELY AFFECTED

This section identifies the ESA-listed species that occur within the action area (Figure 3) that may be affected by be affected by NSF's proposed seismic activities in the northwest Atlantic Ocean, and the Permits and Conservation Division's issuance of an IHA Table 4. All of the species potentially occurring within the action area are ESA-listed in Table 4, along with their regulatory status.

Table 4. Threatened and endangered species that may be adversely affected by NSF and the NMFS Permits and Conservation Division's proposed action of seismic activities in the northwest Atlantic Ocean and the issuance of an Incidental Harassment Authorization.

Species	ESA Status	Critical Habitat	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
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	76 FR 43985
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	75 FR 81584
Sea Turtles			
Green Turtle (*Chelonia mydas*) – North Atlantic Ocean DPS	E – 43 FR 32800	63 FR 46693*	63 FR 28359
Leatherback turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710*	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northwest Atlantic DPS	T – 76 FR 58868	79 FR 39856*	63 FR 28359
Loggerhead Turtle (*Caretta caretta*) – Northeast Atlantic DPS	E – 76 FR 58868	-- --	63 FR 28359

*Critical habitat has been designated, but it is outside the action area and will not be affected by the proposed action.

8.1 Status of Species Likely to be Adversely Affected

This section examines the status of each species 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 these NMFS Web sites: [https://www.fisheries.noaa.gov/welcome].

One factor affecting the range wide status of whales, sea turtles, and aquatic habitat at large is climate change. Climate change will be discussed in the Environmental Baseline section.

8.1.1 Blue Whale

The blue whale is a widely distributed baleen whale found in all major oceans (Figure 4).

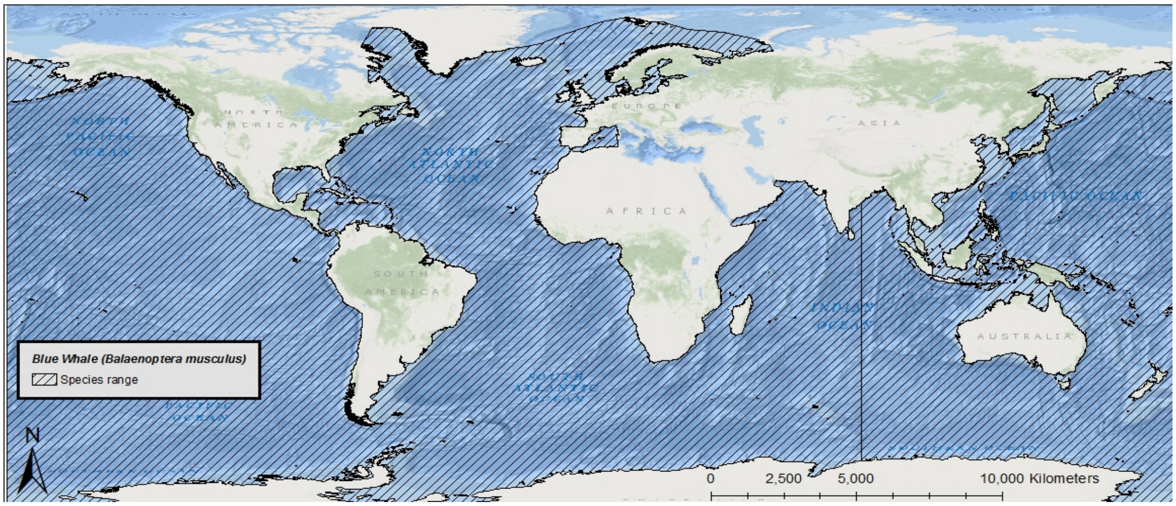


Figure 4. Map identifying the range of the blue whale.

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. The blue whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

Information available from the recovery plan (NMFS 1998), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016), and status review (COSEWIC 2002) were used to summarize the life history, population dynamics and status of the species as follows. There are three stocks of blue whales designated in U.S. waters. Of these, the western North Atlantic stock occupies the North Atlantic Ocean from mid-latitudes to Arctic waters, and individuals from this stock are likely to be affected by the proposed action.

8.1.1.1 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 6 to 7 months. Blue whales reach sexual maturity between 5 and 15 years of age with an average calving interval of 2 to 3 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 meters.

8.1.1.2 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, North Pacific, and Southern Hemisphere. The western North Atlantic stock and has a population estimate of N = 400 to 600 (N_{min} = 440).

An overall population growth rate for the species or a growth rate for the western North Atlantic stock are not available at this time.

Little genetic data exist on blue whales globally. 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 (less than 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, 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. Four important feeding areas have been identified in Canadian waters: the lower St. Lawrence Estuary, the northwestern Gulf of St. Lawrence, the shelf waters south and southwest of Newfoundland, and the Mecatina Trough area. Blue whales in the region appear to use the Honguedo and Cabot Straits as transit routes (Lesage et al. 2018). Blue whales have also been sighted over the Mid-Atlantic Ridge (Waring et al. 2008b).

8.1.1.3 Vocalization and Hearing

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5 to 400 Hz, with dominant frequencies from 16 to 25 Hz. Their songs span frequencies from 16 to 60 Hz that last up to 36 seconds repeated every 1 to 2 minutes (see Cummings and Thompson 1971; Cummings 1977; Edds-Walton 1997a; Edds 1982; McDonald et al. 1995a; Thompson 1982). Non-song vocalization are also low-frequency in nature (generally below 200 Hz, but one of six types up to 750 Hz) between 0.9 and 4.4 seconds long (Redalde-Salas 2014). Berchok et al. (2006) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17.0 to 78.7 Hz. Reported source levels are 180 to 188 dB re 1µPa, but may reach 195 dB re 1µPa (Aburto et al. 1997; Clark and Ellison 2004; Ketten 1998; McDonald et al. 2001). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re 1 μPa_{rms} at 1 meter in the 17 to 30 Hz range and pygmy blue whale calls at 175± 1 dB re 1 μPa_{rms} at 1 meter in the 17 to 50 Hz range. Source levels around Iceland have been 158 to 169 dB re 1 μPa_{rms} (Rasmussen 2013). Direct studies of blue whale hearing have not been conducted, but it is assumed that blue whales can hear the same frequencies that they produce (low-frequency) and are likely most sensitive to this frequency range (Ketten 1997; Richardson et al. 1995c).

Vocalizations attributed to blue whales have been recorded in presumed foraging areas, along migration routes, and during the presumed breeding season (Beamish 1971; Cummings et al. 1972; Cummings and Thompson 1971; Cummings and Thompson 1994; Cummings 1977; Rivers 1997; Thompson 1996). Blue whale calls appear to vary between western and eastern North Pacific regions, suggesting possible structuring in populations (Rivers 1997; Stafford et al. 2001).

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 1997b; Payne and Webb 1971; Thompson et al. 1992a). Intense bouts of long, patterned sounds are common from fall through spring in low latitudes, but these also occur less frequently during summer in high-latitude feeding areas. Short, rapid sequences of 30 to 90 Hz calls are associated with socialization and may be displays by males based on call seasonality and structure.

8.1.1.4 Status

The blue whale is endangered because of past commercial whaling. In the North Atlantic, at least 11,000 blue whales were taken from the late 19th to mid-20th centuries. Commercial whaling no longer occurs, but blue whales in the action area are at risk from the same threats as blue whales elsewhere in the North Atlantic, such as vessel strikes, entanglement in fishing gear, pollution, and reduced prey abundance and habitat degradation due to climate change. Although populations range-wide appear to be increasing in size, the blue whale population in the North Atlantic does not have a growth rate available, and is numbered at 440 individuals.

8.1.1.5 Critical Habitat

No critical habitat has been designated for the blue whale.

8.1.1.6 Recovery Goals

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 down list blue whales.

8.1.2 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* is found in the Northern Hemisphere (Figure 5).

On the U.S. West Coast, fin whales are distributed off California, Oregon, and Washington.

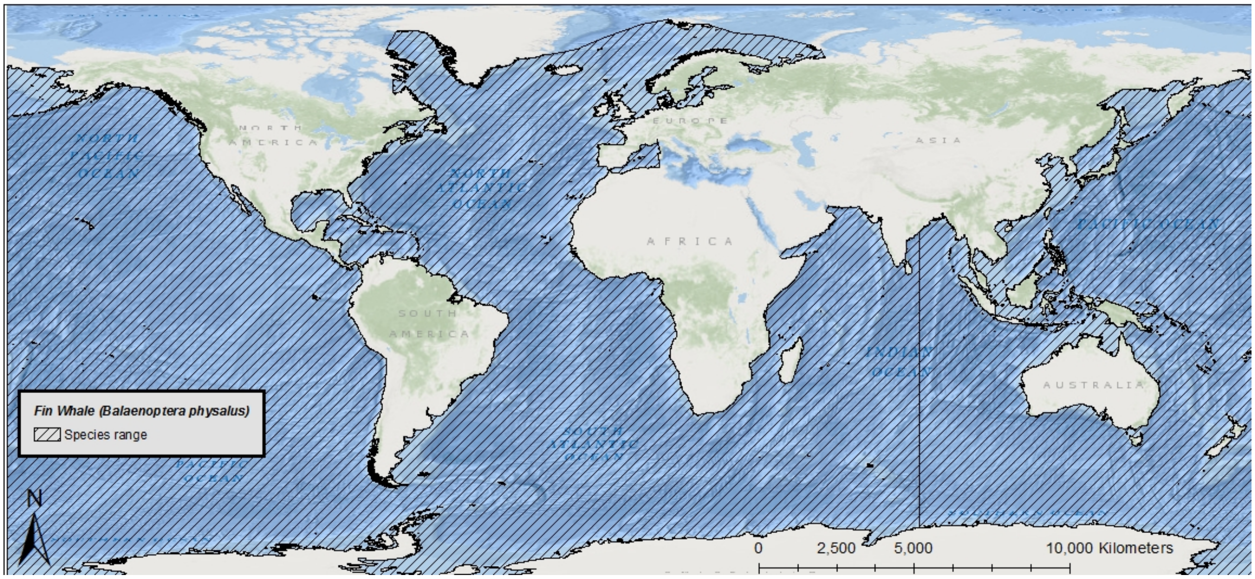


Figure 5. Map identifying the range of the fin whale

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 fin whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Globally, there are several stocks of fin whales; we expect that individuals from the western North Atlantic stock are the most likely to be exposed to the proposed action.

Information available from the recovery plan (NMFS 2010b), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016), and status review (NMFS 2011a) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.2.1 Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than 1 year, and calves nurse for 6 to 7 months. Sexual maturity is reached between 6 and 10 years of age with an average calving interval of 2 or 3 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. Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lice.

8.1.2.2 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.

In the North Atlantic, at least 55,000 fin whales were killed between 1910 and 1989. Of the three to seven stocks in the North Atlantic (approximately 50,000 individuals), one occurs in U.S. waters, where the best estimate of abundance is 1,618 individuals (N_{min}=1,234); however, this may be an underrepresentation as the entire range of stock was not surveyed (Palka 2012).

Current estimates indicate approximately 9,000 fin whales in U.S. Pacific Ocean waters, with an annual growth rate of 4.8 percent in the Alaska stock and 3.5 percent in the California/Oregon/Washington stock. Overall population growth rates and total abundance estimates for the Hawaii stock and western north Atlantic stock 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 mtDNA genome for 154 fin whales sampled in the North Atlantic, North Pacific, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least 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, 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 ocean basins. Such high genetic diversity and lack of differentiation within ocean basins may indicate that despite some population's 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, North Pacific, and Southern Hemisphere where they appear to be reproductively isolated. The availability of sand lice, in particular, is thought to have had a strong influence on the distribution and movements of fin whales.

8.1.2.3 Vocalization and Hearing

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

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

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

8.1.2.4 Status

The fin whale is endangered because of past commercial whaling. Prior to commercial whaling, hundreds of thousands of fin whales existed. Up to 19 fin whales may be killed under "aboriginal subsistence whaling" by tribes in Greenland (IWC 2016) and under Iceland's formal objection to the Commission's ban on commercial whaling. It is unknown how harvest would affect fin whales in the action area, but the aboriginal harvest catch rates are reviewed and approved by the International Whaling Commission so as not to be detrimental to the population. In the western North Atlantic (i.e., U.S. waters), there are about 1,600 fin whales, with no trend information available. The International Whaling Commission considers fin whales in the central North Atlantic and off West Greenland to be robust (about 4,500)[1]. Additional threats that affect fin

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[1] https://iwc.int/estimate

whales throughout their range as well as in the action area include vessel strikes, reduced prey availability due to overfishing or climate change, and noise.

8.1.2.5 Critical Habitat

No critical habitat has been designated for the fin whale.

8.1.2.6 Recovery Goals

See the 2010 Final Recovery Plan for the fin whale for complete down listing/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.

8.1.3 Sei Whale

The sei whale is a widely distributed baleen whale found in all major oceans (Figure 6). Sei whales in the northwestern Atlantic Ocean are found along the U.S. coast over the continental shelf, to south of Newfoundland, and east to longitude 42° West. Globally, there are several stocks of sei whales; we expect that individuals from the Nova Scotia stock are the most likely to be exposed to the proposed action.

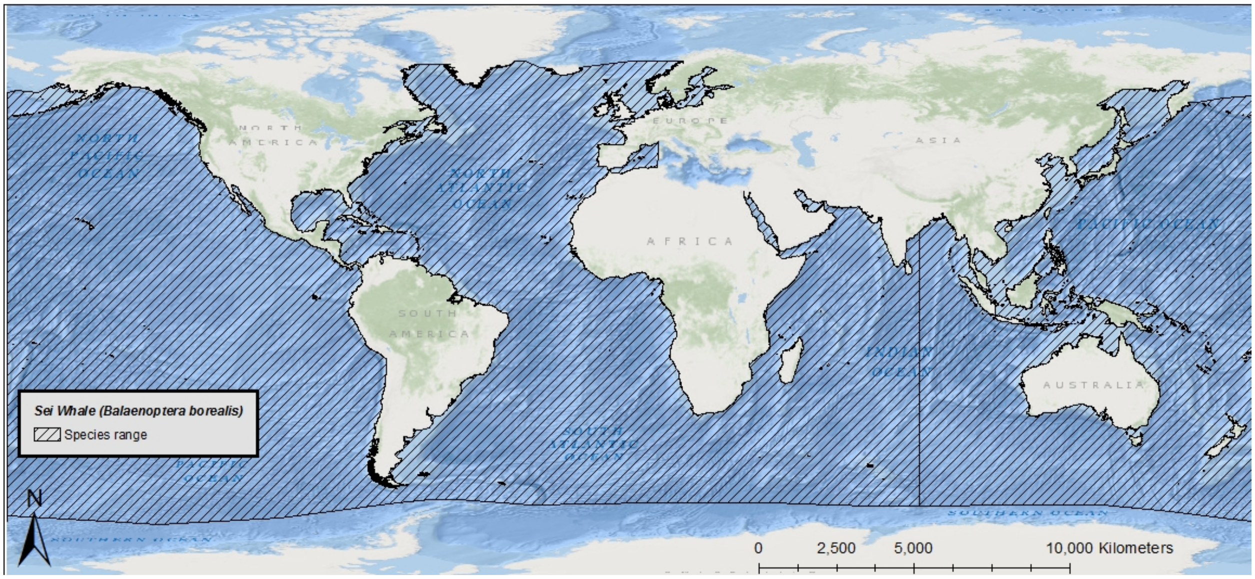

Figure 6. Map identifying the range of the sei whale.

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. Two subspecies of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. The sei whale was originally listed as endangered on December 2, 1970 (35 FR 18319).

Information available from the recovery plan (NMFS 2011b), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016), and status review (NMFS 2012) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.3.1 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 6 to 9 months. Sexual maturity is reached between 6 and 12 years of age with an average calving interval of 2 to 3 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.

8.1.3.2 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 subspecies 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. Models indicate that total abundance declined from 42,000 to 8,600 individuals between 1963 and 1974 in the North Pacific. In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 whales, with recent abundance estimated at 9,700 whales. Three stocks occur in U.S. waters: Nova Scotia (N=357, N_{min}=236), Hawaii (N=178, N_{min}=93), and Eastern North Pacific (N=126, N_{min}=83). There are no population estimates for sei whales in the action area, although there are reports of sightings in the region. In a 2004 survey, sei whales were the most abundant whale species sighted (Waring et al. 2008).

Population growth rates for sei whales are not available at this time.

While some genetic data exist sei whales, current samples sizes are small limiting our confidence in their estimates of genetic diversity (NMFS 2011b). 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 (less than 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.

There are approximately 80,000 sei whales worldwide, occurring in the North Atlantic, North Pacific, and Southern Hemisphere.

8.1.3.3 Vocalization and Hearing

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

8.1.3.4 Status

There is little information available about sei whales in the action area, although we can expect that the threats the species faces are similar throughout its range. The sei whale is endangered because of past commercial whaling. Current threats include vessel strikes, fisheries interactions (including entanglement), climate change (habitat loss and reduced prey availability), and noise. The species' large population size may provide some resilience to current threats, but trends are largely unknown.

8.1.3.5 Critical Habitat

No critical habitat has been designated for the sei whale.

8.1.3.6 Recovery Goals

See the 2011 Final Recovery Plan for the sei whale for complete down listing/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.

8.1.4 Sperm Whale

The sperm whale is a widely distributed whale found in all major oceans (Figure 7). Off the U.S. East Coast, sperm whales are found over the continental shelf edge, continental slope, and into mid-ocean regions.

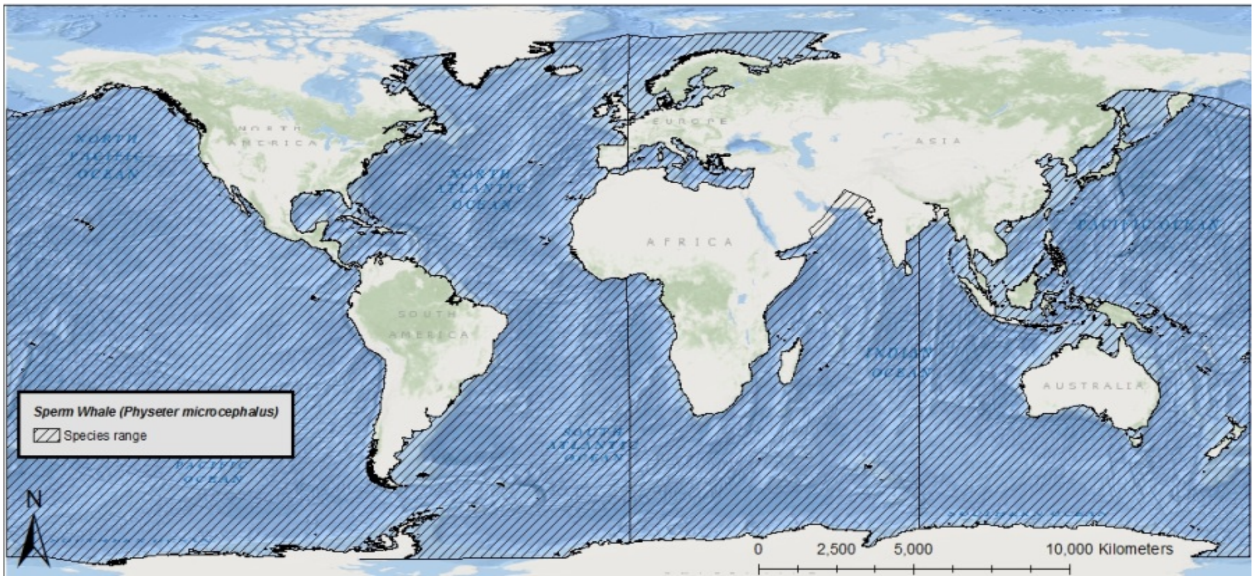

Figure 7. Map identifying the range of the sperm whale.

Sperm whales are the largest toothed whale and distinguishable from other whales by its extremely large head, which takes up to 25 percent 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 (35 FR 18319).

Information available from the recovery plan (NMFS 2010a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016), and status review (NMFS 2015b) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.4.1 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 2 years. Sexual maturity is reached between 7 and 13 years of age for females with an average calving interval of 4 to 6 years. Male sperm whales reach full sexual maturity in their twenties. Sperm whales mostly inhabit areas with a water depth of 600 meters (1,968 feet) or more, and are uncommon in waters less than 300 meters (984 feet) 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).

8.1.4.2 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 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 six recognized stocks of sperm whales in U.S. waters. Abundance for sperm whales in the North Atlantic is estimated at N=2,288 (considered an underestimate).

There is insufficient data to evaluate trends in abundance and growth rates of sperm whales in the North Atlantic 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 indicate low genetic diversity (Mesnick et al. 2011; Rendell et al. 2012). 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 40º, only adult males venture into the higher latitudes near the poles. In shipboard and aerial surveys, they are commonly sighted near the 1,000-meter isobaths.

8.1.4.3 Vocalization and Hearing

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

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

8.1.4.4 Status

There are no abundance estimates for sperm whales in the action area, or even the western North Atlantic Ocean, and no population trend information, either, so much is unknown about sperm whale status in the action area specifically. Generally, though, the sperm whale is endangered because 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 at biologically unsustainable levels. Many of the continued threats to sperm whale populations range-wide include vessel strikes, entanglement in fishing gear, competition for resources due to overfishing, pollution, loss of prey and habitat due to climate change, and noise. These threats are likely also affecting sperm whales in the action area. The species' large population size shows that it is somewhat resilient to current threats.

8.1.4.5 Critical Habitat

No critical habitat has been designated for the sperm whale.

8.1.4.6 Recovery Goals

See the 2010 Final Recovery Plan for the sperm whale for complete down listing/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.

8.1.5 Green Sea Turtle North Atlantic Ocean Distinct Population Segment

The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The North Atlantic DPS green turtle is found in the North Atlantic Ocean and Gulf of Mexico (Figure 8) and is listed as threatened.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two 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 eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057).

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

8.1.5.1 Life history

Age at first reproduction for females is 20 to 40 years. Green sea 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 2 to 5 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 sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea 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.

8.1.5.2 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 North Atlantic DPS green sea turtle.

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, 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). Occasional nesting has also been documented along the Gulf Coast of Florida (Meylan et al. 1995).

For the North Atlantic DPS, 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 of 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 has a distinct haplotype from other green turtles around the world, 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 subpopulations in Florida, Cuba, Mexico and Costa Rica (Shamblin et al. 2016).

Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north. The range of the DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa. Nesting occurs primarily in Costa Rica, Mexico, Florida and Cuba.

In U.S. Atlantic and Gulf of Mexico waters, green sea turtles are distributed throughout inshore and nearshore waters from Texas to Massachusetts. Principal benthic foraging areas in the southeastern United States include Aransas Bay, Matagorda Bay, Laguna Madre, and the Gulf inlets of Texas (Doughty 1984; Hildebrand 1982; Shaver 1994), the Gulf of Mexico off Florida from Yankeetown to Tarpon Springs (Caldwell and Carr 1957), Florida Bay and the Florida Keys (Schroeder and Foley 1995), the Indian River Lagoon system in Florida (Ehrhart 1983), and the Atlantic Ocean off Florida from Brevard through Broward Counties (Guseman and Ehrhart 1992; Wershoven and Wershoven 1992). The summer developmental habitat for green sea turtles also encompasses estuarine and coastal waters from North Carolina to as far north as Long Island Sound (Musick and Limpus 1997). Additional important foraging areas in the western Atlantic include the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, scattered areas along Colombia and Brazil (Hirth 1971), and the northwestern coast of the Yucatán Peninsula.

8.1.5.3 Status

There is no information available regarding the status of North Atlantic DPS green turtles in the action area. Instead, we consider the status of the DPS range-wide, which would be present in the action area. Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principal 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 sea 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.

8.1.5.4 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.

8.1.5.5 Recovery Goals

See the 1998 and 1991 recovery plans for the Pacific, East Pacific and Atlantic populations of green turtles for complete down-listing/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.

8.1.6 Leatherback Sea Turtle

The leatherback sea 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 subpolar latitudes, worldwide (Figure 9).

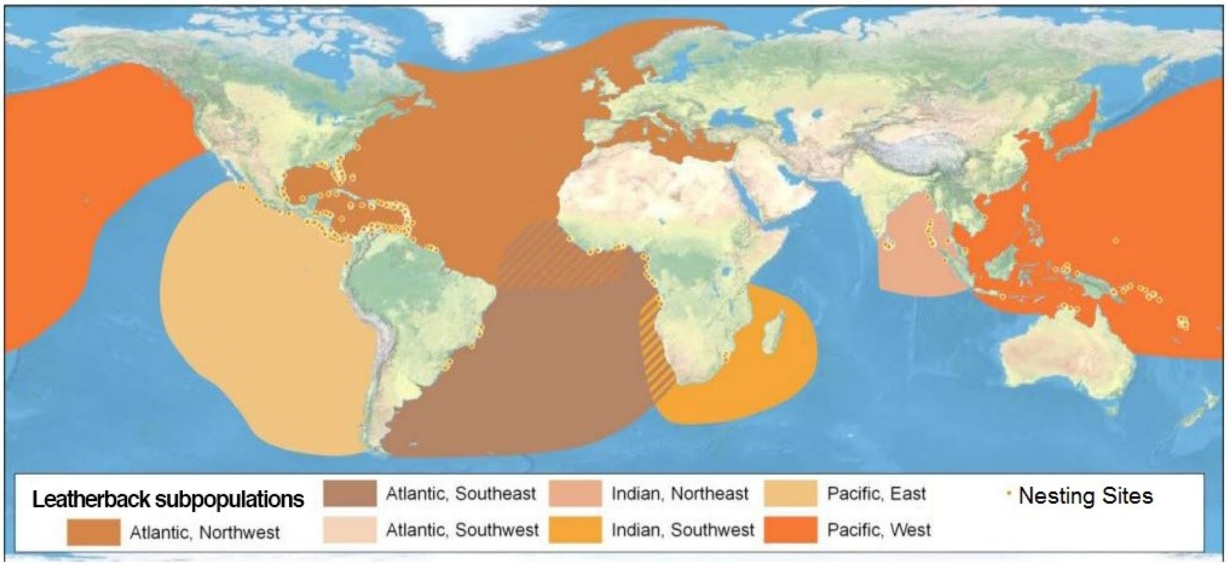

Figure 9. Map identifying the range of the leatherback sea turtle. Adapted from (Wallace et al. 2010).

Leatherbacks are the largest living turtle, reaching lengths of 6 feet long, and weighing up to 1 ton. Leatherback sea 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 (35 FR 8491) and listed as endangered under the ESA since 1973.

We used information available in the five year review (NMFS 2013a) and the critical habitat designation (77 FR 61573) to summarize the life history, population dynamics and status of the species, as follows.

8.1.6.1 Life History

Age at maturity has been difficult to ascertain, with estimates ranging from 5 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 hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50 percent worldwide (Eckert et al. 2012). Females nest every 1 to 7 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 sea 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 leatherbacks must consume large quantities to support their body weight. Leatherbacks 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 (James et al. 2005; Wallace et al. 2006). 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).

8.1.6.2 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 sea turtle.

Leatherbacks are globally distributed, with nesting beaches in the Pacific, Atlantic, and Indian 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 leatherbacks in the North Atlantic (TEWG 2007a). In contrast, leatherback populations in the Pacific are much lower. Overall, Pacific populations have declined 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 ten females nest per year from 1994 to 2004, and about 296 nests per year counted in South Africa (NMFS 2013a).

Population growth rates for leatherback sea turtles vary by ocean basin. Counts of leatherbacks at nesting beaches in the western Pacific indicate that the subpopulation has been declining at a rate of almost 6 percent per year since 1984 (Tapilatu et al. 2013). Leatherback subpopulations in the Atlantic Ocean, however, are showing signs of improvement. Nesting females in South Africa are increasing at an annual rate of 4 to 5.6 percent, and from 9 to 13 percent in Florida and the U.S. Virgin Islands (TEWG 2007a), believed to be a result of conservation efforts.

Analyses of mitochondrial DNA from leatherback sea 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 2013a). Genetic analyses using microsatellite markers along with mitochondrial DNA and tagging data indicate there are seven groups or breeding populations in the Atlantic Ocean: Florida, Northern Caribbean, Western Caribbean, Southern Caribbean/Guianas, West Africa, South Africa, and Brazil (TEWG 2007b).

Leatherback sea turtles are distributed in oceans throughout the world. Leatherbacks occur throughout 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).

8.1.6.3 Status

Atlantic leatherbacks comprise the individuals that would be present in the action area, most likely originating from nesting beaches in the Caribbean. Generally, Atlantic leatherback populations are increasing, and considered more robust than their counterparts in the Pacific Ocean. Still, the leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Regulations imposed on U.S. fisheries are believed to have reduced leatherback bycatch and mortality in the Atlantic (Finkbeiner et al. 2011). Sub-adult and adult leatherbacks are captured incidentally in fisheries in Canada (e.g., Nova Scotia and Newfoundland) (Hamelin et al. 2017). Other threats elsewhere in the range of the species 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.

8.1.6.4 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.

8.1.6.5 Recovery Goals

See the 1998 and 1991 Recovery Plans for the U.S. Pacific and U.S Caribbean, Gulf of Mexico and Atlantic leatherback sea turtles for complete down listing/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.

8.1.7 Loggerhead Sea Turtles Northwest and Northeast Atlantic Ocean Distinct Population Segments

Loggerhead sea turtles are circumglobal, and are found in the temperate and tropical regions of the Indian, Pacific and Atlantic Oceans. The proposed action area covers the range of two distinct population segments of loggerhead sea turtles: Northwest Atlantic Ocean and Northeast Atlantic Ocean. The two population segments are split along the 40° West longitude line.

Northwest Atlantic Ocean DPS loggerheads are found along eastern North America, Central America, and northern South America (Figure 10).

Figure 10. Map identifying the range of the Northwest Atlantic Ocean distinct population segment loggerhead sea turtle.

Northeast Atlantic Ocean DPS loggerheads are found in the northeastern Atlantic Ocean, from Western Europe to western Africa (Figure 11).

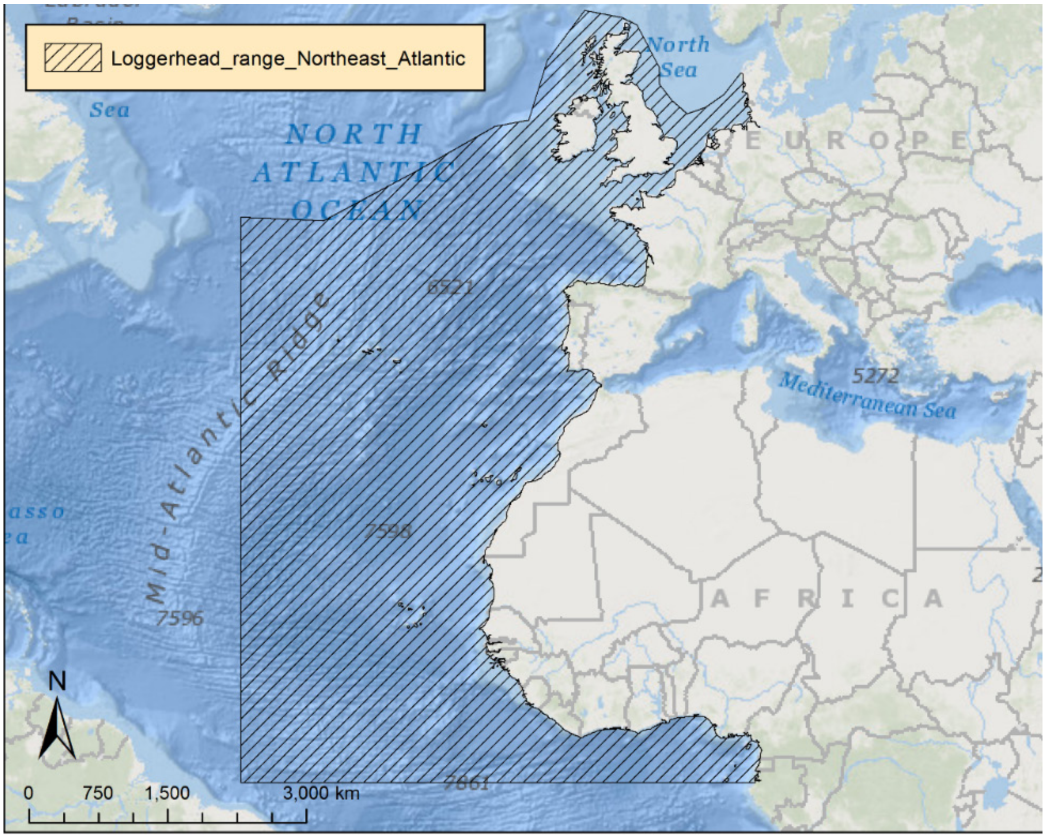

Figure 11. Map identifying the range of the Northeast Atlantic Ocean distinct population segment loggerhead sea turtle.

The loggerhead sea turtle is distinguished from other turtles by its reddish-brown carapace, large head and powerful jaws. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine distinct population segments of loggerhead sea turtles, with the Northwest Atlantic Ocean DPS listed as threatened, and the Northeast Atlantic Ocean DPS listed as endangered (75 FR 12598).

8.1.7.1 Life History

Mean age at first reproduction for female loggerhead sea turtles is thirty 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 turtle during the middle of the incubation period. 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 sub-adult and adult loggerheads. Loggerheads return to their natal region for mating and nesting. While in their oceanic phase, loggerheads undergo long migrations using ocean currents. Individuals from multiple nesting colonies can be found on a single feeding ground.

8.1.7.2 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 distribution as it relates to the Northeast Atlantic Ocean and Northwest Atlantic Ocean DPS loggerhead sea turtle.

There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size. Adult nesting females often account for less than 1 percent of total population numbers (Bjorndal et al. 2005).

Northeast Atlantic Ocean DPS

Loggerheads of the Northeast Atlantic Ocean DPS nest on the islands of the Cape Verde Archipelago, off the coast of western Africa. Boavista Island hosts the largest nesting aggregation, with over 10,000 nests annually, making it the third largest loggerhead nesting population in the world (Marco et al. 2010). Annually, about 1,000 nests were observed in 2009 at Sal island, and the islands of Maio and Sao Nicolau support about 500 nests each (Lino et al. 2010; Marco et al. 2010). Limited nesting occurs on beaches along the coast of Morocco and Senegal (Fretey 2001).

There was not sufficient time series nesting data to calculate population growth rates for the Northeast Atlantic Ocean DPS in the 2009 Status Review (Conant et al. 2009b).

The Cape Verde Archipelago hosts the highest concentration of Northeast Atlantic Ocean DPS nesting, with most nesting occurring on Boa Vista Island. Mitochondrial DNA analysis of nesting females on Boa Vista Island reveals that the Cape Verde nesting assemblage is genetically distinct from other rookeries, and more similar to Northwest Atlantic Ocean rookeries than those in the nearby Mediterranean (Conant et al. 2009b; Monzon-Arguello et al. 2009).

Loggerheads from the eastern Atlantic can migrate west to feeding grounds. Individuals from the Cape Verde nesting beaches can be found in foraging aggregations in Nicaragua (4 percent), Panama (3.8 percent), Azores and Madeira (7.2 percent), Canary Islands and Andalusia (6.2 percent), Gulf of Mexico (2 percent), the southern Atlantic coast of Florida (2.5 percent), and Brazil (1 percent) (Masuda 2010). Juvenile loggerheads from Cape Verde are thought to drift predominantly westward using the southern branch of the North Atlantic gyre (Monzón-Argüello et al. 2012).

Northwest Atlantic Ocean DPS

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-SEFSC 2009). Based on genetic information, the Northwest Atlantic Ocean DPS 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 DPS, with an average of 5,215 nests from 1989 to 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 DPS (Ehrhart et al. 2003).

The Greater Caribbean Recovery Unit encompasses nesting subpopulations 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, 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).

The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 to 2004 (excluding 2002), which provided a mean of 246 nests per year, or about 60 nesting females (NMFS and USFWS 2007).

The Gulf of Mexico Recovery Unit has between 100 to 999 nesting females annually, and a mean of 910 nests per year.

The population growth rate for each of the four of the recovery units for the Northwest Atlantic DPS (Peninsular Florida, Northern, Northern Gulf of Mexico, and Greater Caribbean) all exhibit negative growth rates (Conant et al. 2009b).

Nest counts taken at index beaches in Peninsular Florida show a significant decline in loggerhead nesting from 1989 to 2006, most likely attributed to mortality of oceanic-stage loggerheads caused by fisheries bycatch (Witherington et al. 2009). Loggerhead nesting on the Archie Carr National Wildlife Refuge (representing individuals of the Peninsular Florida subpopulation) 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 nests at the 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 nesting beaches in North Carolina, South Carolina and Georgia declined at 1.9 percent annually from 1983 to 2005 (NMFS and USFWS 2007).

The nesting subpopulation in the Florida panhandle has exhibited a significant declining trend from 1995 to 2005 (Conant et al. 2009b; NMFS and USFWS 2007). Recent model estimates predict an overall population decline of 17 percent for the St. Joseph Peninsula, Florida subpopulation of the Northern Gulf of Mexico recovery unit (Lamont et al. 2014).

Based on genetic analysis of nesting subpopulations, the Northwest Atlantic Ocean DPS is further divided into five recovery units: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean (Conant et al. 2009b). 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 coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS should be considered as ten 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 hatchlings from the western Atlantic disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Mitochondrial DNA evidence demonstrates that juvenile loggerheads 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: Nicaragua, Panama, Azores and Madeira, Canary Islands and Andalusia, Gulf of Mexico and Brazil (Masuda 2010).

8.1.7.3 Status

Two DPSs of loggerhead turtles comprise the species in the action area: the Northeast Atlantic Ocean DPS and Northwest Atlantic Ocean DPS. There is no information about the status of any DPS of loggerhead turtles in the action area. Instead, we consider the status of the DPSs as a whole. Loggerhead turtles occupy different environments at different life stages, and threats that influence a DPS at one life stage can influence the status of the loggerhead turtles in the action area.

Due to the on-going harvest of females, low hatchling and emergence success, and mortality of juveniles and adults from fishing bycatch, the Northeast Atlantic Ocean DPS is predicted to have a high likelihood of decline (Conant et al. 2009b).

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

8.1.7.4 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). No critical habitat has been designated for the Northeast Atlantic Ocean DPS loggerhead turtle. NMFS cannot designate critical habitat in foreign waters. There is no loggerhead critical habitat in the action area and it will not be considered in this opinion.

8.1.7.5 Recovery Goals

In response to the current threats facing the species, NMFS developed goals to recover loggerhead turtle populations. NMFS has not developed a Recovery Plan for the Northeast Atlantic Ocean DPS loggerhead sea turtle. In general, listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990). See the 2009 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads for complete downlisting/delisting criteria for the recovery objectives listed below.

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 inter-nesting 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.

9 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 impacts of state or private actions which are contemporaneous with the consultation in process (50 C.F.R. §402.02).

9.1 Climate Change

We primarily discuss climate change as a threat common to all species addressed in this opinion, rather than in each of the species-specific narratives.

The 2014 Assessment Synthesis Report from the Working Groups on the Intergovernmental Panel on Climate Change 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 meters [246 feet] have warmed by 0.11 degrees Celsius per decade over the period 1971 to 2010) (IPCC 2014). Global mean sea level rose by 0.19 meters (0.62 feet) 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). Additional consequences of climate change include increased ocean stratification, decreased sea-ice extent, altered patterns of ocean circulation, and decreased ocean oxygen levels (Doney 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, heat waves, and droughts (IPCC 2014). Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Though predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered in this opinion, is difficult (Simmonds 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 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. He 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 sea turtles were predicted to gain core habitat area, whereas loggerhead sea turtles were predicted to experience losses in available core habitat. McMahon and Hays (2006) predicted increased ocean temperatures would expand the distribution of leatherback sea 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 likely to be negatively affected. Willis-Norton et al. (2015) acknowledged there would be both habitat loss and gain, but overall determined climate change could result in a 15 percent loss of core pelagic habitat for leatherback sea turtles in the eastern South Pacific Ocean.

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

Similarly, climate-mediated changes in important prey species' populations are likely to affect predator populations. For ESA-listed sea turtles that undergo long migrations (e.g., leatherbacks), 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).

Climate-mediated changes in the distribution and abundance of keystone prey species like krill and climate-mediated changes in the distribution of cephalopod populations worldwide is likely to affect marine mammal populations as they re-distribute throughout the world’s oceans in search of prey. If sea ice extent decreases, then larval krill may not be able to survive without access to under ice algae to feed on. 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). If they did not change their distribution or could not find the biomass of krill necessary to sustain their population numbers, their populations would likely experience declines similar to those observed in other krill predators, including dramatic declines in population size and increased year-to year variation in population size and demographics. These outcomes would dramatically increase the extinction probability of baleen whales. Edwards et al. (2007) found a 70 percent decrease in one zooplankton species in the North Sea and an overall reduction in plankton biomass as warm-water species invade formerly cold-water areas. Sims et al. (2001) found the timing of squid peak abundance in the English Channel advanced by 120 to 150 days in the warmest years compared with the coldest. Bottom water temperatures correlated with the extent of squid movement, and temperature increases over the 5 months before and during the month of peak squid movement did not differ between early and late years. These authors concluded that the temporal variation in peak abundance of squid seen off Plymouth represents temperature-dependent movement, which climatic changes associated with the North Atlantic Oscillation would potentially affect. Cephalopods dominate the diet of sperm whales, which would likely re-distribute following changes in the distribution and abundance of their prey. If, however, cephalopod populations collapse or decline dramatically, sperm whales would likely decline as well.

Changes in global climatic patterns are expected to have profound effects on coastlines worldwide, potentially having significant consequences for the ESA-listed species considered in this opinion that are partially dependent on terrestrial habitat areas (i.e., sea turtles) during a portion of their life cycle. For example, rising sea levels are projected to inundate some sea turtle nesting beaches (Caut et al. 2009; Wilkinson 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 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, and 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 2009; Fuentes et al. 2009; Fuentes et al. 2010; Glen 2003). All of these temperature related impacts have the potential to significantly impact sea turtle reproductive success and ultimately, long-term species viability. Poloczanska (2009) noted that extant sea turtle species have survived past climatic shifts, including glacial periods and warm 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 that because the current rate of warming is very rapid, expected change might outpace sea turtles' ability to adapt.

This is not an exhaustive review of all available literature regarding the potential impacts of climate change to the species considered in this opinion. However, this review provides some examples of impacts that may occur. While it is difficult to accurately predict the consequences of climate change to the species considered in this opinion, a range of consequences are expected, ranging from beneficial to catastrophic.

9.2 Harvest

Prior to 1900, aboriginal hunting and early commercial whaling on the high seas, using hand harpoons, took an unknown number of whales (Johnson and Wolman 1984). Modern commercial whaling removed about 50,000 whales annually. In 1965, the International Whaling Commission banned the commercial hunting of whales. Although commercial harvesting no longer targets whales in the proposed action area, prior exploitation may have altered the population structure and social cohesion of the species such that effects on abundance and recruitment can continue for years after harvesting has ceased.

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 several species, including the sea turtles considered in this opinion. At present, despite conservation efforts such as bans and moratoriums by the responsible governments, the harvest of sea turtles and their eggs on nesting beaches still occurs throughout parts of their range. Harvest of green turtles and their eggs continues in the Caribbean and at beaches in the eastern Atlantic (Seminoff 2015). For the Northeast Atlantic Ocean DPS loggerhead, harvest of eggs and hatchlings remains a threat to the species (Conant 2009). Harvest of leatherback females and eggs in the Atlantic is not as severe a threat as it is the Pacific, but still occurs (NMFS 2013a).

9.3 Noise

Noise generated by human activity has the potential to affect whales and sea turtles, although effects to sea turtles are not well understood. This includes sound generated by commercial and recreational vessels, aircraft, commercial sonar, military activities, seismic exploration, in-water construction activities and other human activities. These activities all occur within the action area to varying degrees throughout the year. Whales generate and rely on sound to navigate, hunt and communicate with other individuals. As a result, anthropogenic noise can interfere with these important activities. The effects of noise on marine mammals can range from behavioral effects to physical damage (Richardson et al. 1995b).

Commercial shipping traffic is a major source of low-frequency anthropogenic noise in the oceans (NRC 2003a). Although large vessels emit predominantly low-frequency sound, studies report broadband noise from large cargo ships that includes significant levels above 2 kHz, which may interfere with important biological functions of cetaceans (Holt 2008a). Commercial sonar systems are used on recreational and commercial vessels and may affect marine mammals (NRC 2003a). Although, little information is available on potential effects of multiple commercial sonars to marine mammals, the distribution of these sounds would be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Richardson et al. 1995b).

Seismic surveys using towed air guns occur within the action area and are the primary exploration technique to locate oil and gas deposits, fault structures, and other geological hazards. Air guns 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 2003a). Most of the energy from the guns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from air guns usually reach 235 to 240 dB at dominant frequencies of 5 to 300 Hz (NRC 2003a). Most of the sound energy is at frequencies below 500 Hz.

9.4 Fisheries Interactions

Globally, 6.4 million tons of fishing gear is lost in the oceans every year (Wilcox et al. 2015). Entrapment and entanglement in fishing gear is a frequently documented source of human-caused mortality in marine mammals (see Dietrich et al. 2007). These entanglements also make animals more vulnerable to additional dangers (e.g., predation and vessel strikes) by restricting agility and swimming speed. Marine mammals that die from entanglement in commercial fishing gear often sink rather than strand ashore thus making it difficult to accurately determine the extent of such mortalities. Between 1970 and 2009, two-thirds of mortalities of large whales in the northwestern Atlantic were attributed to human causes, primarily ship strike and entanglement (Van der Hoop et al. 2013). In excess of 97 percent of entanglement is caused by derelict fishing gear (Baulch and Perry 2014).

Marine mammals probably consume at least as much fish as is harvested by humans (Kenney et al. 1985). Therefore, competition with humans for prey is a potential concern for whales. Reductions in fish populations, whether natural or human-caused, may affect listed whale populations and their recoveries. Whales are known to feed on several species of fish that are harvested by humans (Waring et al. 2008a); however, the magnitude of competition is unknown.

Fishery interaction remains a major factor in sea turtle recovery and, frequently, the lack thereof. Wallace et al. (2010) estimated that worldwide, 447,000 turtles are killed each year from bycatch in commercial fisheries. NMFS (2002) estimated that 62,000 loggerhead sea turtles have been killed as a result of incidental capture and drowning in shrimp trawl gear. Although 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. In the Mediterranean, incidental bycatch in fisheries is a significant threat to sea turtles, with an estimated 132,000 captures per year, and about 44,000 mortalities (Casale 2011). The North Atlantic Oscillation appears to influence the amount of sea turtles captured in Spanish purse seine fisheries; years with a positive North Atlantic Oscillation phases had significantly higher numbers of sea turtles captured than negative years (Báez et al. 2018).

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

9.5 Vessel Strike

Vessels have the potential to affect whales through strikes, noise and disturbance associated with their physical presence. Responses to vessel interactions include interruption of vital behaviors and social groups, separation of mothers and young and abandonment of resting areas (Boren et al. 2001; Constantine 2001; Mann et al. 2000; Nowacek 2001; Samuels et al. 2000). Whale watching, a profitable and rapidly growing business with more than 9 million participants in 80 countries and territories, may increase these types of disturbance and negatively affect the species (Hoyt 2001).

Vessel strikes are considered a serious and widespread threat to marine mammals. 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 from which they were previously extirpated (Swingle 1993; Wiley et al. 1995). There is a concern that many vessel strikes go undetected and unreported because the whale's carcass sinks (Cassoff 2011). As ships continue to become faster and more widespread, an increase in ship interactions with marine mammals is to be expected. For whales, studies show that the probability of fatal injuries from vessel strikes increases as vessels operate at speeds above 14 knots (Laist et al. 2001).

Boat collisions can result in serious injury and death and may pose a threat to sea turtles in the action area although the extent of this threat is unknown.

9.6 Pollution

Within the action area, pollution poses a threat to ESA-listed whales and leatherback sea turtles. Pollution can come in the form of marine debris, pesticides, contaminants, and hydrocarbons.

9.6.1 Marine Debris

Marine debris is introduced into the marine environment through ocean dumping, littering, or hydrologic transport of these materials from land-based sources, and presents a significant ecological threat (Gallo et al. 2018). Even natural phenomena, such as tsunamis and continental flooding, can cause large amounts of debris to enter the ocean environment. Whales often become entangled in marine debris. They may also ingest it while feeding, potentially leading to digestive problems, injury, or death. Types of marine debris include plastics, glass, metal, polystyrene foam, rubber and derelict fishing gear from maritime activities or land-based sources. Marine debris has been discovered to be accumulating in gyres throughout the oceans. Law et al. (2010) presented a time series of plastic content at the surface of the western North Atlantic Ocean and Caribbean Sea from 1986 to 2008. More than 60 percent of 6,136 surface plankton net tows collected small, buoyant plastic pieces. The data identified an accumulation zone east of Bermuda that is similar in size to the accumulation zone in the Pacific Ocean.

Whales become entangled in marine debris, or ingest it, which may lead to injury or death. Over half of cetacean species (including fin, sei, and sperm whales) are known to ingest marine debris (mostly plastic), with up to 31 percent of individuals in some populations having marine debris in their guts. Marine debris is also the cause of death for up to 22 percent of individuals found stranded on shorelines (Baulch and Perry 2014).

Given the limited knowledge about the impacts of marine debris on whales, it is difficult to determine the extent of the threats that marine debris poses to whales. However, marine debris is consistently present and has been found in whales in and near the action area. In January and February 2016, 30 sperm whales stranded along the coast of the North Sea (in Germany, the Netherlands, Denmark, France, and Great Britain). Of 22 dissected specimens, nine had marine debris in their gastrointestinal tracts of which (78 percent) was fishing-related debris (e.g., nets, monofilament line) and the remainder (22 percent) was general debris (plastic bags, plastic buckets, agricultural foils) (Unger et al. 2016). Fin whales in the Mediterranean Sea are exposed to high densities of microplastics in their feeding grounds, and in turn exposed to a higher oxidative stress because of the presence of plasticizers, an additive in plastics (Fossi et al. 2016).

Ingestion of marine debris can be a serious threat to sea turtles. When feeding, leatherback sea turtles can mistake debris (e.g., tar and plastic) for natural food items, especially jellyfish, a primary prey item. Other types of marine debris, such as discarded or derelict fishing gear, may entangle and drown sea turtles. Plastic ingestion is very common in leatherbacks and can block gastrointestinal tracts leading to death (Mrosovsky 2009). In a study looking at oceanic-stage juvenile loggerheads on a feeding ground near the Azores, 83 percent (twenty turtles) had ingested plastic marine debris (Pham et al. 2017). Green turtles in their oceanic life stage are also vulnerable to pollutants like tar balls because they tend to accumulate in *Sargassum* mats at convergence zones, where young green turtles associate (Seminoff 2015).

9.6.2 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 as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993).

The accumulation of persistent pollutants through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals (Waring et al. 2008a), including immune system abnormalities, endocrine disruption and reproductive effects (Krahn et al. 2007). Recent efforts have led to improvements in regional water quality 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).

Numerous factors can affect concentrations of persistent pollutants in marine mammals, such as age, sex and birth order, diet, and habitat use (Mongillo et al. 2012). In marine mammals, pollutant contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987; Borrell et al. 1995). Pollutants can be transferred from mothers to offspring at a time when their bodies are undergoing rapid development, putting them at risk for immune and endocrine system dysfunction later in life (Krahn et al. 2009).

In sea turtles, varieties of heavy metals have been found in tissues in levels that increase with turtle size (Anan et al. 2001; Barbieri 2009; Fujihara et al. 2003; Garcia-Fernandez et al. 2009; Gardner et al. 2006; Godley et al. 1999; Saeki et al. 2000; Storelli et al. 2008). Cadmium has been found in leatherbacks 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 eggs are laid, suggesting that metals may be accumulated from surrounding sands during incubation (Sahoo et al. 1996).

Sea turtle tissues have been found to contain organochlorines and many other persistent organic pollutants. Polychlorinated biphenyl (better known as PCB, found in engine coolants) concentrations in sea turtles are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500-530 ng/g wet weight; Davenport 1990; Oros 2009). PCBs have been found in leatherback sea turtles at concentrations lower than expected to cause acute toxic effects, but might cause sub-lethal effects on hatchlings (Stewart 2011).

Organochlorines could cause deficiencies in endocrine, developmental and reproductive health (Storelli et al. 2007) and are known to depress immune function in loggerhead sea 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.

9.6.3 Hydrocarbons

Exposure to hydrocarbons released into the environment via oil spills, urban runoff, burning fossil fuels, 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). 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). Hydrocarbons also have the potential to impact prey populations and therefore may affect listed species indirectly by reducing food availability.

9.7 Science and Research Activities

Scientific research permits issued by the NMFS currently authorize studies of listed species in the North Atlantic Ocean, some of which extend into portions of the action area for the proposed project. These activities may result in harassment, stress, and, in limited cases, injury or mortality. In addition, there may be scientific research permits issued by numerous other entities (e.g., the National Parks Service, National Ocean Service, National Marine Sanctuaries, etc.) for studies on species and habitat related to their respective missions and statutory responsibilities. In those cases, each Federal agency would be obligated to conduct ESA section 7 consultations as necessary.

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. 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 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, and captive experiments. Most authorized take is sub-lethal but a limited number result in mortality.

There are no known seismic surveys for research purposes with a MMPA incidental take authorization from NMFS scheduled to occur near the Mid-Atlantic Ridge in the North Atlantic Ocean. There is a seismic research survey proposed by the U.S. Geological Survey to take place off the U.S. East Coast in the U.S. Exclusive Economic Zone in August 2018. This action is the subject of a separate, on-going ESA section 7 consultation.

9.8 Synthesis of the Baseline Impacts

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 remain at low population levels. 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.

10 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 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.

10.1 Stressors Associated with the Proposed Action

The potential stressors we expect to result from the proposed action are:

1. Pollution by oil or fuel leakage
2. Ship-strikes
3. Acoustic interference from engine noise
4. Entanglement in towed hydrophone streamer
5. Sound fields produced by air guns, sub-bottom profiler, and multibeam echosounder.

As noted earlier 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, disturbance from vessel noise, and entanglement are not likely to adversely affect ESA-listed species because their effects are insignificant or discountable.

10.1.1 Pollution by Oil or Fuel Leakage

The potential for fuel or oil leakages is extremely unlikely. 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. Research vessels used in NSF-funded seismic surveys have spill-prevention plans, which would allow a rapid response to a spill in the event one occurred (NSF 2011). In the event that a leak should occur, the amount of fuel and oil onboard the *Atlantis* is unlikely to cause widespread, high dose contamination (excluding the remote possibility of severe damage to the vessel) that would impact listed species directly or pose hazards to their food sources. Because the potential for fuel or oil leakage is extremely unlikely to occur, we find that the risk from this potential stressor is discountable. Therefore, we conclude that pollution by oil or fuel leakage is not likely to adversely affect ESA-listed whales or sea turtles, and will not be analyzed further.

10.1.2 Vessel Strike

We are not aware of a ship-strike by a seismic survey vessel. The *Atlantis* will be traveling at generally slow speeds, reducing the amount of noise produced by the propulsion system and the probability of a ship-strike (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). Our expectation of vessel strike is discountably small due to the hundreds of thousands of kilometers the *Atlantis* has traveled without a vessel strike. We generally expect marine mammals to move away or parallel to the *Atlantis*, to avoid being struck. Furthermore, the generally slow movement of the *Atlantis* during most of its travels reduce the chances of vessel strike (Hauser and Holst 2009; Holst 2009; Holst 2010; Holst and Smultea 2008a). Adherence to observation and avoidance procedures is also expected to avoid vessel strikes. All factors considered, we have concluded the potential for vessel strike from the research vessel is highly improbable. Because the potential for vessel strike is extremely unlikely to occur, we find that the risk from this potential stressor is discountable. Therefore, we conclude that vessel strike is not likely to adversely affect ESA-listed whales or sea turtles and will not be analyzed further.

10.1.3 Disturbance from Engine Noise

We expect that the *Atlantis* will add to the local noise environment in its operating area due to the propulsion and other noise characteristics of the vessel's machinery. This contribution is likely small in the overall regional sound field. The *Atlantis'* passage past a whale or sea turtle would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of whales and sea turtles to move away from vessels, either as a result of engine noise, the physical presence of the vessel, or both (Lusseau 2006). In addition, the *Atlantis* will be traveling at slow speeds, reducing the amount of noise produced by the propulsion system (Kite-Powell et al. 2007; Vanderlaan and Taggart 2007). The distance between the vessel and observed marine mammals and sea turtles, per avoidance protocols, would also minimize the potential for acoustic disturbance from engine noise. Because the potential acoustic interference from engine noise would be undetectable or so minor that it could not be meaningfully evaluated, we find that the risk from this potential stressor is insignificant. Therefore, we conclude that acoustic interference from engine noise is not likely to adversely affect ESA-listed whales or sea turtles and will not be analyzed further.

10.1.4 Gear Entanglement

The towed hydrophone streamer could come in direct contact with a listed species and sea turtle entanglements have occurred in towed seismic gear. For example, a seismic survey off the coast of Costa Rica during 2011 recovered a dead olive ridley sea turtle in the foil of towed seismic gear; it is unclear whether the sea turtle became lodged in the foil pre- or post mortem (Spring 2011). However, entanglement is highly unlikely due to the streamer design as well as observations of sea turtles investigating the streamer and not becoming entangled or operating in regions of high turtle density and entanglements not occurring (Hauser 2008; Holst and Smultea 2008a; Holst et al. 2005a; Holst et al. 2005b). To the best of our knowledge, sea turtles do not occur in high densities in the action area. Instances of such entanglement events with ESA-listed whales are unknown to us. Although the towed hydrophone streamer or passive acoustic array could come in direct contact with a listed species, entanglements are highly unlikely.

Deployment of oceanographic and bottom sampling equipment is standard practice aboard deep-water research vessels, including those used by Lamont-Doherty Earth Observatory under National Science Foundation-funded activities (Haley and Koski 2004; MacLean and Koski 2005). We are unaware of entanglements or other interactions between the equipment used for this research and ESA-listed species since the 2011 event. We expect the taut cables used to raise and lower equipment will prevent entanglement. Based upon extensive deployment of this type of equipment with no reported entanglement and the nature of the gear that is likely to prevent it from occurring, we find the probability of adverse impacts to ESA-listed species to be discountable and it will not be analyzed further.

10.2 Mitigation to Minimize or Avoid Exposure to Acoustic Energy

Accordingly, this consultation focused on the following stressor likely to occur from the proposed seismic activities and may adversely affect ESA-listed species: acoustic energy introduced into the marine environment by the air gun array and the multibeam echosounder and sub-bottom profiler. NSF's proposed action includes the use of exclusion zones, protected species observers and operational shutdown in the presence of ESA-listed species. The NMFS' Permits and Conservation Division's proposed IHA would contain additional mitigation measures to minimize or avoid exposure (see Appendix A).

10.3 Exposure Analysis

Exposure analyses identify the ESA-listed species that are likely to co-occur with the actions' effects on the environment in space and time, and identify the nature of that co-occurrence. The *Exposure Analysis* identifies, as possible, the number, age or life stage, and gender of the individuals likely to be exposed to the actions' effects and the population(s) or subpopulation(s) those individuals represent. The *Response Analysis* also considers information on the potential for stranding and the potential effects on the prey of ESA-listed whales and sea turtles in the action area.

Although there are multiple acoustic and non-acoustic stressors associated with the proposed action, the stressor of primary concern is the acoustic impacts of air guns.

The NSF applied acoustic thresholds to determine at what point during exposure to the airgun arrays marine mammals are "harassed," based on definitions provide in the MMPA (16 U.S.C. §1362(18)(a)). As part of the application for the IHA pursuant to the MMPA, the NSF provided an estimate of the number of marine mammals that would be exposed to levels of sound in which they would be considered "taken" under the MMPA during the proposed survey. NSF did not provide any take estimates from sound sources other than the air guns, although other equipment producing sound will be used during air gun operations (e.g., the multibeam echosounder and the sub-bottom profiler). In their Federal Register Notice of the proposed IHA, the NMFS' Permits and Conservation Division stated that they did not expect the sound emanating from the other equipment to exceed that of the air gun array. Therefore, the NMFS' Permits and Conservation Division did not expect additional exposure from sound sources other than the air guns. Since the sub-bottom profiler and the multibeam echosounder have a lower or roughly equivalent source output as the air gun array (Section 3.1.2 and Section 3.1.3), we agree with this assessment and similarly focus our analysis on exposure from the air gun array.

During the development of the IHA, the NMFS' Permits and Conservation Division conducted an independent exposure analysis. In this section, we describe both the NSF and the NMFS analytical methods to estimate the number of ESA-listed species that might be exposed to the sound field and experience an adverse response.

The methodology for estimating the number of ESA-listed species that might be exposed to the sound field used by NSF and the NMFS' Permits and Conservation Division were largely the same. Both estimated the number of marine mammals predicted to be exposed to sound levels that would result in harassment by using radial distances to predicted isopleths. Both used those distances to calculate the ensonified area around the air gun array for 160dB zone, which corresponds to the Level B harassment threshold for ESA-listed marine mammals. To account for possible delays during the survey (e.g., weather, equipment malfunction), a 25 percent contingency was added in the form of operational days, which is equivalent to adding 25 percent to the proposed line kilometers to be surveyed.

Since the survey would involve surveying the six survey grids twice at two different tow depths, creating two different-sized ensonified areas, the NSF calculated both daily ensonified areas. For the 5-knot survey, the daily ensonified area was 240.68 square kilometers (km^2), and 412.1 km^2 for the 8-knot survey. These daily ensonified areas were multiplied by the total survey days (7.5 and 17.5 days, for the 5 and 8-knot surveys, respectively), then multiplied by 1.25 to account for operational contingency, as described above (2,256.33 and 9,014.56 km^2). The two figures were combined, resulting in the total ensonified area across all survey days: 11,271 km^2.

Both NSF and the NMFS Permits and Conservation Division used density estimates from (Mannocci et al. 2017) and those available at http://seamap.env.duke.edu/models/AFTT-2015/, also authored by the same authors as Mannocci et al.(2017); see the next section for more details. The estimated density of each marine mammal species within an area (animals/km^2) is multiplied by the total ensonified areas (km^2) that correspond to the Level B harassment thresholds for the species. The product (rounded) is the estimated number of instances of take for each species. The result is an estimate of the number of instances that marine mammals are predicted to be exposed to air gun sounds above the Level B harassment threshold over the duration of the proposed survey. The total area estimated to be ensonified to the Level B harassment threshold for the proposed survey is 11,271 km^2.

The NSF also requested take for North Atlantic right whales and bowhead whales by calculating the mean group size for each species from Jefferson et al. (2015) because no other density information was available. Their purpose in doing so is to ensure that the proposed action has an adequate amount of take authorization. Based on what we know about the range and distribution of North Atlantic right whales and bowhead whales in the action area, we believe that that these species would be in the action area and thus not exposed to the proposed action. The Permits and Conservation Division agreed with our assessment, and North Atlantic right whales and bowhead whales were not considered in the opinion and not included in the IHA.

Upon discussions with the NMFS' Permits and Conservation Division and the NSF, we agreed to adopt the exposure numbers (Table 5) developed through the calculation method described above. In cases where the calculated exposure was lower than the mean group size (i.e., blue whales), we increased the exposure to the mean group size. Our rationale was that in the event that a group was encountered during the survey, it was reasonable to expect that the number of individuals in that group would more likely be the mean group size, and less likely that it would be fewer than that amount.

For our ESA consultation, we evaluated the method for estimating the number of ESA-listed individuals that would be exposed relative to the definition of harassment discussed above. We concur with the analysis presented by the NMFS' Permits and Conservation Division and the NSF.

NMFS applies certain acoustic thresholds to help determine at what point during exposure to seismic airgun arrays (and other acoustic sources) marine mammals are considered "harassed" under the MMPA. These thresholds are used to develop radii for exclusion zones around a sound source and the necessary power-down or shut-down criteria to limit marine mammals and sea turtles' exposure to harmful levels of sound (NOAA 2016). The 160 dB re: 1 μPa (rms) distance is the distance at which MMPA take, by Level B harassment, is expected to occur, and the threshold at which the NMFS Permits and Conservation Division is proposing to issue authorization for incidental take of marine mammals. The 175 dB re: 1 μPa (rms) isopleth represents our best understanding of the threshold at which sea turtles exhibit significant behavioral responses to airgun arrays, and the 195 dB re: 1 μPa (rms) isopleth will serve as the exclusion radii for sea turtles.

Exposures to acoustic sound sources with levels 20 dB above those producing TTS are assumed to produce a PTS. An onset-TTS criterion of 175 dB re: 1 μPa (rms) will have corresponding onset-PTS criteria of 195 dB re: 1 μPa (rms). This extrapolation process is identical to that proposed by Southall (2007). The method overestimates or predicts greater effects than have actually been observed in tests on a bottlenose dolphin (Finneran 2010; Schlundt 2006) and is therefore protective.

NMFS has not yet defined "harass" under the ESA in regulation. 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." The MMPA of 1972, as amended, defines "harassment" as "any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but no limited to, migration, breathing, nursing, breeding, feeding, or sheltering" (16 U.S.C. §1362(18)(A)). The latter portion of this definition (that is, "…causing disruption of behavioral patterns including…migration, breathing, nursing, breeding, feeding, or sheltering") is similar to language in the U.S. Fish and Wildlife Service's regulatory definition of "harass" pursuant to the ESA. NMFS ESA Interagency Cooperation Division has relied on the MMPA definition of Level B harassment in estimating the number of instances of harassment of ESA-listed marine mammals for this opinion. Given the complexity associated with modeling and calculating take estimates for marine mammals, consistent with prior consultations for seismic surveys for scientific research purposes, NMFS continues to rely on the MMPA definition of Level B harassment to evaluate whether the NMFS Permits and Conservation Division's proposed incidental harassment authorization for the seismic survey in the North Atlantic Ocean is likely to lead to harassment of ESA-listed species and to estimate the number of instances of harassment of ESA-listed marine mammals considered in this opinion.

Air guns contribute a massive amount of anthropogenic energy to the world's oceans (3.9×10^{13} joules cumulatively), second only to nuclear explosions (Moore and Angliss 2006). Although most energy is in the low-frequency range, air guns emit a substantial amount of energy up to 150 kHz (Goold and Coates 2006). Seismic air gun noise can propagate substantial distances at low frequencies (e.g., Nieukirk et al. 2004a).

The exposure analysis for this opinion is concerned with the number of fin, sei, blue, and sperm whales, as well as leatherback, North Atlantic DPS green, Northeast Atlantic Ocean and Northwest Atlantic Ocean DPS loggerhead sea turtles likely to be exposed to received levels greater than 160 dB re 1 μPa_{rms} (175 dB for sea turtles), which constitute the best estimate of adverse response by ESA-listed whales and sea turtles. The NSF and NMFS' Permits and Conservation Division estimated the expected number of ESA-listed whales exposed to receive levels ≥160 dB re 1 μPa_{rms}. The NMFS' Permits and Conservation Division's data and methodology used were adopted in this opinion because the NMFS' ESA Interagency Cooperation Division believed they represent the best available information and methods to evaluate exposure to listed species.

10.3.1 Exposure Analysis: Whales

Blue, fin, sei, and sperm whales of all age classes are likely to be exposed. Given that the survey will take place in mid-June to mid-July, we expect that most whales will be on or migrating to their feeding grounds. Whales are expected to be feeding, traveling, or migrating in the area and some females would have young-of-the-year accompanying them. We would normally assume that sex distribution is even for fin, sei, and blue whales, and sexes are exposed at a relatively equal level. However, sperm whales in the area likely consist of groups of adult females and their offspring and generally consist of more females than males in the group. Therefore, we expect a female bias to sperm whale exposure. For sperm whales, exposure for adult male sperm whales is expected to be lower than other age and sex class combinations.

Table 5. Exposure estimates of ESA-listed species in the action area.

Species	**Exposure Estimate**
Fin Whale	90
Sei Whale	113
Sperm Whale	451
Blue Whale	1

The proposed seismic activity is taking place in a remote location where we do not have a great deal of information on species density for ESA-listed whales. To the best of our knowledge, only a few studies have attempted to calculate species density over the Mid-Atlantic Ridge (e.g., (Nieukirk et al. 2004b; Sigurjonsson et al. 1991). The most recent study that took place near the proposed action area is Waring et al. (2008b), and even that survey was only able to calculate density for five species (out of 21 species sighted during the cruise) due to an overall low encounter rate. For ESA-listed whales, Waring et al. (2008b) was only able to calculate density for sei and sperm whales. Using this source of data to calculate exposure would not have been sufficient for ESA consultation, or for the Permits and Conservation Division to calculate incidental harassment for the non-listed marine mammals. For the purposes of calculating exposure for the proposed action, it was necessary to find other sources of density data.

In its initial request, the NSF used density estimates from Waring et al. (2008), or derived a density from that source, for fin, sei, blue, and sperm whales. For other non-listed species, the NSF used (Mannocci et al. 2017) to calculate take estimates. The species-specific models in Mannocci et al. 2017 were created using line transect survey data from numerous sources, including from the U.S. East Coast and the Gulf of Mexico (Roberts et al. 2016), European Atlantic (Hammond et al. 2013; Hammond et al. 2009), and the Mid-Atlantic Ridge (Waring et al. 2008b). The modeled area in Mannocci et al. (2017) from the U.S. East Coast to approximately 45° West longitude, outside of most of the seismic survey areas (all except survey Area 1). However, the NSF used the eastern-most area of the model between the survey latitudes to obtain estimated density for several non-listed marine mammals.

Both the ESA Interagency Cooperation Division and the Permits and Conservation Division had concerns over using the density estimates from Waring et al. (2008b) even for the few species for which estimates were available. The data were about 10 years old, and based on relatively few sightings. We considered the Mannocci et al. 2017 data to be the best available information because it encompassed several other sources of data (including (Waring et al. 2008b) and habitat covariates to predict density. When comparing the calculated densities from Waring et al. (2008b) to the eastern-most area of the Mannocci et al. (2017) model, the estimates were similar. Waring et al. (2008b) estimated sei whale density to be 0.018 (animals per square kilometer); Mannocci et al. (2017) estimated 0.01 animals per square kilometer. Waring et al. (2008b) calculated two sperm whale density estimates for the northern and southern survey areas: 0.042 (North) and 0.036 (South) animals per square kilometer; Mannocci et al. (2017) estimated 0.04 animals per square kilometer. After discussion, the NSF re-submitted their Environmental Assessment using the Mannocci et al. (2017) data. At this point, we accepted the exposure estimates, and proceeded with the consultation.

10.3.2 Exposure Analysis: Sea Turtles

During the proposed action, ESA-listed sea turtles may be exposed to sound from three sources: the air guns, the multibeam echosounder and sub-bottom profiler. NSF did not provide estimates for the expected number of ESA-listed sea turtles exposed to received levels greater than or equal to 175 dB re 1 μPa_{rms}. Our exposure estimates stem from the best available information on sea turtle densities and a predicted root mean squared radius of approximately 103-meters (8-meter air gun separation) and 91-meters (2-meter air gun separation) along survey track lines. Based on information presented in the *Response Analysis*, we expect all exposures at the 175 dB re 1 μPa_{rms} level, which constitute the best estimate of adverse response by ESA-listed sea turtles.

10.3.2.1 Exposure of ESA-listed sea turtles to air guns

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 (1990b) and McCauley et al. (2000c), who experimentally examined behavioral responses of sea turtles in response to seismic airguns. O’Hara and Wilcox (1990b) 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. (2000c) 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. 2000c). 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 take by behavioral harassment.

NSF presented estimated distances for the 175 dB re 1 μPa_{rms} sound levels presented by the two 45-in^3 generator-injector guns. When the array is towed with 2-meter gun separation, in waters greater than 1,000-meters deep, the predicted established distance at received levels is 91-meters. When the array is towed with 8-meter gun separation, in waters greater than 1,000-meters deep, the predicted established distance at received levels is 103-meters. These are the distances at which sea turtles could be expected to react in a manner that could lead to a fitness consequence either through reduced foraging ability, avoidance, increased swimming speed, erratic behavior, startle and diving, and stress as a result of the sound created by the airgun array.

As discussed in the *Status of listed resources* section, the ESA-listed sea turtle species that are likely to be affected by the proposed action are North Atlantic green, Northwest Atlantic Ocean loggerhead, Northeast Atlantic loggerhead, and leatherback sea turtles.

Estimating exposure for sea turtles in the action area was challenging, as there is scant information on sea turtle density, population estimates, or occurrence specific to the waters of the North Atlantic Ocean, near the Mid-Atlantic Ridge. To estimate exposure, we relied on recent reports and scientific literature focusing on sea turtles in the area.

North Atlantic DPS green turtle

Significant nesting sites for the green turtle North Atlantic DPS occur in the southeastern United States and in the Gulf of Mexico, with lesser sites throughout Central America and the Caribbean. On the eastern side of the Atlantic Ocean, nesting for the DPS occurs in Mauritania (Seminoff 2015). The timing of nesting varies by region, but in the southeastern United States, nesting occurs in June through September. Hatchlings emerge from the nests about sixty days after nesting. The action would occur in mid-June to mid-July, when we would expect nesting females to be at the nesting beaches or transiting to them. The earliest we would expect hatchlings to emerge from their nests would be August. While foraging, adult green turtles occupy nearshore and inshore environments, where they feed on algae and sea grass. The proposed action area is in the middle of the North Atlantic Ocean, outside of the area where we expect foraging adult green turtles to occupy.

There is some possibility that adult green turtles may be transiting through the action area, as there is evidence of adult female green turtles making trans-Atlantic movements. Female green turtles tagged on Ascension Island at their nesting site were later found on feeding grounds off the coast of Brazil (Luschi et al. 1998; Papi et al. 2000). While we are not aware of adult green turtles in the North Atlantic Ocean making similar movements, it would seem to be unlikely to occur. The vast majority of nesting beaches for the North Atlantic DPS green turtle are in the western Atlantic Ocean, and there are several known feeding areas in the vicinity. As such, an adult green turtle there would have little reason to transit the Atlantic Ocean to forage. The nesting beach in the eastern Atlantic is in Mauritania, where there is also an important feeding ground, and green turtles are found throughout the year.

Neritic (i.e., nearshore) juveniles are found as far north as Cape Cod Bay, as far east as Bermuda, and throughout the Caribbean. In the eastern Atlantic, juvenile green turtles are found year-round in Mauritania (Seminoff 2015). There are no known foraging areas in the action area, and we do not expect neritic juvenile green turtles to be exposed to the proposed action.

Since there are no nesting sites in or near the action area, and due to the timing and location of the action, we do not expect nesting females, foraging adults, neritic juveniles, or green turtle hatchlings to be exposed to the proposed action.

After hatching and emerging from the nest, green turtle hatchlings begin their oceanic life stage. Post-hatchlings spend a few years at sea until they are large enough as a juvenile to come inshore like the adults. Due to the difficulty of tracking post-hatchlings or observing them in the ocean, there is a large gap in our understanding of green turtle behavior in their oceanic phase. The post-hatchlings are thought to use ocean currents like the Gulf Stream to move offshore, where they associate with *Sargassum* mats (Witherington et al. 2006; Witherington and Hirama 2006). It is possible that oceanic post-hatchling green turtles could be exposed to the proposed action.

Northwest Atlantic Ocean and Northeast Atlantic Ocean DPSs loggerhead sea turtle

There are two DPSs of loggerhead sea turtles that may be exposed to the proposed action: Northwest Atlantic Ocean and Northeast Atlantic Ocean. Loggerhead sea turtles nest in late April through early September; the action will take place in mid-June through mid-July. The action area is in the middle of the North Atlantic Ocean, well away from any coasts. We do not expect nesting females to be exposed to the proposed action, as they will either be nesting or traveling to the nesting beach when the action would take place.

Neritic juveniles typically are found in continental shelf waters less than 200 meters deep, using estuaries with limited ocean access. Non-nesting adult loggerheads prefer shallow water habitats with open ocean access (Conant et al. 2009a). Since the proposed action will take place in deep waters greater than 200 meters in depth, we do not expect neritic juvenile and non-nesting adult loggerheads of either DPS to be exposed to the proposed action.

Juveniles from the Northeast Atlantic Ocean DPS originating in the Cape Verde Islands forage at the Canary Islands, Madeira, the Azores, and Andalusia; there are believed to be other unknown foraging areas (Monzon-Arguello et al. 2009). Since juvenile loggerheads from the Cape Verde Islands are thought to drift westward on the southern branch of the North Atlantic Gyre (Monzón-Argüello et al. 2012), we do not expect them to be exposed because that current is south of the action area. Genetic tests confirmed that juvenile loggerheads from the Northwest Atlantic Ocean DPS have been found on foraging areas in the eastern Atlantic, including the Azores, Madeira, the Canary Islands, and Andalusia (Bolten et al. 1998; Monzon-Arguello et al. 2009; Revelles et al. 2007). However, since there are no foraging areas in the action area, we do not expect foraging juveniles from either DPS to be exposed to the proposed action.

There is evidence to show that post-hatchling loggerheads from the Northwest Atlantic Ocean DPS overlap with loggerheads from the Northeast Atlantic Ocean DPS in the western Mediterranean (Carreras et al. 2006). Like green sea turtles, post-hatchling loggerheads are also thought to use ocean currents once leaving their nests, associating with *Sargassum* mats.

Oceanic-phase juvenile loggerheads from either DPS could pass through the action area while drifting with *Sargassum* mats on the ocean currents that make up the North Atlantic Gyre (e.g., the Gulf Stream, the North Atlantic Current), and be exposed to the proposed action.

Leatherback sea turtles

Of all the sea turtles, leatherbacks most consistently occupy the oceanic environment. After nesting, adults undergo long-distance migrations to foraging grounds. For leatherbacks in the Atlantic, this means that after nesting in the Caribbean, Puerto Rico, the U.S. Virgin Islands (among other places), adult females travel to foraging areas in the North Atlantic, like Nova Scotia and Newfoundland. There are no known foraging areas for leatherbacks in the action area, but satellite-tagged adult female leatherbacks did transit through the action area (Bailey et al. 2012). Females nest every 2 or 3 years, and the migration from the nesting beach to the foraging area can take months. Sub-adult and adult leatherbacks are captured incidentally in fisheries off Nova Scotia and Newfoundland, with peak captures occurring in July and August (Hamelin et al. 2017). Based on this information, and the location of the activities, we expect that leatherbacks transiting to the foraging areas would be exposed to the proposed action.

As is the case for other species, there are gaps in what we know about where leatherback sea turtles go after hatching. One hypothesis is that leatherback post-hatchlings drift passively on ocean currents for a year or two, the initiate active swimming seasonally, towards warm water in winter and towards higher latitudes in spring to feed (Gaspar et al. 2012). Hatchlings emerge from their nests after about 2 months. The timing of nesting varies, but in Puerto Rico, nesting occurs from mid-March to July (Diez et al. 2008). We would expect leatherback hatchlings to be emerging from their nests starting in mid-May through September. It is possible that post-hatchling leatherbacks be exposed to the proposed action.

We are unable to quantify the level of sea turtle exposure. We expect sea turtle exposure to occur because the available information indicates that the species is present in the action area during the proposed seismic activities. As discussed earlier, there are no reliable sea turtle population estimates for the North Atlantic Ocean near the Mid-Atlantic Ridge. Thus, it is not possible to quantify the proportion of the overall population that may be exposed to the proposed activity.

10.3.2.2 Exposure of ESA-listed sea turtles to multibeam echosounder and sub-bottom profiler

Sea turtles hear in the low frequency range. The multibeam echosounder operates at 10.5 to 13 kHz and the sub-bottom profiler operates at 3.5 kHz, which emit sounds outside the hearing frequency of sea turtles. Thus, sea turtles are not expected to respond to sounds emitted by multibeam echosounder or sub-bottom profiler.

10.3.3 Response Analysis

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

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

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

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

10.3.3.1 Potential responses of ESA-listed whales to acoustic sources

Marine mammals and threshold shifts. Exposure of marine mammals to very strong sound pulses can result in physical effects, such as changes to sensory hairs in the auditory system, which may temporarily or permanently impair hearing. Threshold shift depends upon the duration, frequency, sound pressure, and rise time of the sound. A temporary threshold shift (TTS) results in a temporary hearing change (Finneran 2013), and can last minutes to days. Full recovery is expected. However, a recent mouse study has shown that although full hearing can be regained from TTS (i.e., the sensory cells actually receiving sound are normal), damage can still occur to nerves of the cochlear nerve leading to delayed but permanent hearing damage (Kujawa and Liberman 2009). At higher received levels, particularly in frequency ranges where animals are more sensitive, permanent threshold shift (PTS) can occur, meaning lost auditory sensitivity is unrecoverable. These conditions can result either from a single pulse or from the accumulated effects of multiple pulses, in which case each pulse need not be as loud as a single pulse to have the same accumulated effect. TTS and PTS are 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 (less evident in broadband noise such as the sound sources associated with the proposed action) (Kastak 2005; Ketten 2012; Schlundt 2000).

Few data are available to precisely define each listed species' hearing range, let alone its sensitivity and levels necessary to induce TTS or PTS. Low-frequency baleen whales (e.g., sei, fin, and humpback) have an estimated functional hearing frequency range of 7 Hz to 35 kHz (Table 6).

Table 6. Marine functional mammal hearing groups and their generalized hearing ranges.

Hearing Group	Generalized Hearing Range*
Low Frequency Cetaceans (Baleen Whales)	7 Hz to 35 kHz
Mid-Frequency Cetaceans (Dolphins, Toothed Whales, Beaked Whales, Bottlenose Whales)	150 Hz to 160 kHz
High Frequency Cetaceans (True Porpoises, Kogia spp., River Dolphins, Cephalorhynchid, *Lagenorhynchus cruciger*, and *Lagenorhynchus australis*)	275 Hz to 160 kHz

*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 low frequency cetaceans (Southall 2007).

Based upon captive studies of odontocetes, our understanding of terrestrial mammal hearing, and extensive modeling, the best available information supports the position that sound levels at a given frequency would need to be approximately 186 dB sound exposure level or approximately 196 to 201 dB re 1 μPa_{rms} in order to produce a low-level TTS from a single pulse (Southall et al. 2007). PTS is expected at levels approximately 6 dB greater than TTS levels on a peak-pressure basis, or 15 dB greater on a sound exposure level basis than TTS (Southall et al. 2007). In terms of exposure to the *Atlantis'* air gun array, an individual would need to be within a few meters of the largest air gun to experience a single pulse greater than 230 dB re 1 µPa peak (Caldwell and Dragoset 2000). If an individual experienced exposure to several air gun pulses of approximately 190 dB re 1 μPa_{rms}, PTS could occur. A marine mammal would have to be within 100 meters of the *Atlantis'* air gun array to be within the 190 dB re 1 μPa_{rms} isopleth and risk a TTS. Estimates that are conservative for species impact evaluation are 230 dB re 1 µPa (peak) for a single pulse, or multiple exposures to approximately 198 dB re 1 μPa^2s.

Overall, we do not expect TTS or PTS to occur to any ESA-listed whale because of air gun exposure for several reasons. We expect that individuals will move away from the air gun array as it approaches. As the survey proceeds along each transect line and approaches ESA-listed individuals, the sound intensity increases and individuals will experience conditions (stress, loss of prey, discomfort, etc.) that prompt them to move away from the vessel and sound source and thus avoid exposures that would induce TTS or PTS. Ramp-ups would also reduce the probability of TTS-inducing exposure at the start of seismic surveys for the same reasons, as acoustic intensity increases, animals will move away. Furthermore, mitigation measures would be in place to initiate a power-down if individuals enter or are about to enter the exclusion zone during full air gun operations, which is below the levels believed to be necessary for potential

TTS. As stated in the *Exposure analysis*, each individual is expected to be potentially exposed dozens of times to 160 dB re 1 μPa_{rms} levels. We do not expect this to produce a cumulative TTS, PTS, or other injury for several reasons. We expect that individuals will recover between each of these exposures, we expect monitoring to produce some degree of mitigation such that exposures will be reduced, and (as stated above), we expect individuals to generally move away at least a short distance as received sound levels increase, reducing the likelihood of exposure that is biologically meaningful. In summary, we do not expect animals to be present and exposed to the airgun array for a sufficient duration to accumulate sound pressure levels that will lead to the onset of TTS or PTS.

Marine mammals and auditory interference (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 (Francis 2013). Masking can interfere with an individual's ability to gather acoustic information about its environment, such as predators, prey, conspecifics, and other environmental cues (Marshall 1995). This can result in loss of environmental cues of predatory risk, mating opportunity, or foraging options (Francis 2013). Low frequency sounds are broad and tend to have relatively constant bandwidth, whereas higher frequency bandwidths are narrower (NMFS 2006h).

There is frequency overlap between air gun sounds and vocalizations of ESA-listed whales, particularly baleen whales but also sperm whales. The proposed seismic surveys could mask whale calls at some of the lower frequencies. This could affect communication between individuals, affect their ability to receive information from their environment, or affect sperm whale echolocation (Evans 1998; NMFS 2006h). Most of the energy of sperm whales clicks is concentrated at 2 to 4 kHz and 10 to 16 kHz, and though the findings by Madsen et al. (2006) suggest frequencies of seismic pulses can overlap this range, the strongest spectrum levels of air guns are below 200 Hz (zero to 188 Hz for the *Atlantis* air guns). Any masking that might occur would likely be temporary because seismic sources are not continuous and the seismic vessel would continue to transit through the area.

Given the disparity between sperm whale echolocation and communication-related sounds with the dominant frequencies for seismic surveys, masking is not likely to be significant for sperm whales (NMFS 2006h). Overlap of the dominant low frequencies of air gun pulses with low-frequency baleen whale calls would be expected to pose a somewhat greater risk of masking. The *Atlantis'* air guns will emit a 0.1-second pulse when fired every 8 to 10 seconds. Therefore, pulses will not "cover up" the vocalizations of listed whales to a significant extent (Madsen et al. 2002). We address the response of listed whales stopping vocalizations because of air gun sound in the *Marine mammals and behavioral responses* section below.

Although seismic sound pulses begin as short, discrete sounds, they interact with the marine environment and lengthen through processes such as reverberation. This means that in some cases, such as shallow water environments, seismic sound can become part of the acoustic background. Few studies of how impulsive sound in the marine environment deforms from short bursts to lengthened waveforms exist, but can apparently add significantly to acoustic background (Guerra et al. 2011), potentially interfering with the ability of animals to hear otherwise detectible sounds in their environment.

The sound localization abilities of marine mammals suggest that, if signal and sound come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Marshall 1995). The dominant background noise may be directional if it comes from a particular anthropogenic source such as a ship 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, beluga whale, and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking sound (Bain 1993; Bain 1994; Dubrovskiy 2004). Toothed whales and probably other marine mammals as well, 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 noise (Au 1975; Au 1974; Lesage 1999; Moore 1990; Romanenko 1992; Thomas 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 2004; Holt 2009; Lesage 1999; Lesage 1993; Parks 2009; Parks 2007; Terhune 1999).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of 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, Akopian (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise 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 (Marshall 1995). This ability may be useful in reducing masking at these frequencies. In summary, high levels of sound generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies. For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

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

Several studies have aided in assessing the various levels at which whales may modify or stop their calls in response to air gun sound. Whales continue calling while seismic surveys are operating locally (Greene Jr et al. 1999; Jochens et al. 2006; Madsen et al. 2002; McDonald et al. 1993; McDonald et al. 1995a; Nieukirk et al. 2004a; Richardson et al. 1986; Smultea et al. 2004; Tyack et al. 2003). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic air gun levels increased (Cerchio 2014). Some blue, fin, and sperm whales stopped calling for short and long periods apparently in response to air guns (Bowles et al. 1994; Clark and Gagnon 2006; McDonald et al. 1995a). Fin whales (presumably adult males) engaged in singing in the Mediterranean Sea moved out of the area of a seismic survey while air guns were operational as well as for at least a week thereafter (Castellote et al. 2012). Dunn (2009) tracked blue whales during a seismic survey on the R/V *Maurice Ewing* (*Ewing*) in 2007 and did not observe changes in call rates and found no evidence of anomalous behavior that they could directly ascribe to the use of air guns at sound levels of less than 145 dB re 1 μPa. Blue whales may also attempt to compensate for elevated ambient sound by calling more frequently during seismic surveys (Iorio and Clark 2009). Sperm whales, at least under some conditions, may be particularly sensitive to air gun sounds, as they have been documented to cease calling in association with air guns being fired hundreds of kilometers away (Bowles et al. 1994). Other studies have found no response by sperm whales to received air gun sound levels up to 146 dB re 1 μPa_{p-p} (Madsen et al. 2002; McCall Howard 1999). Some exposed individuals may cease calling in response to the *Atlantis'* air guns. If individuals ceased calling in response to the *Atlantis'* air guns during the course of the proposed survey, the effect would likely be temporary as animals may resume or modify calling at a later time or location.

There are numerous studies of the responses of some baleen whale to air guns. 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. 1995c). Activity of individuals seems to influence response (Robertson 2013), as feeding individuals respond less than mother/calf pairs and migrating individuals (Harris et al. 2007; Malme and Miles 1985; Malme et al. 1984; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995c; Richardson et al. 1999). Surface duration decreased markedly during seismic sound exposure, especially while individuals were engaged in traveling or non-calf social interactions (Robertson 2013). 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. 1995c; Richardson et al. 1999; Richardson et al. 1986). Responses such as stress may occur and the threshold for displacement may simply be higher while feeding. Bowhead calling rate was found to decrease during migration in the Beaufort Sea as well as temporary displacement from seismic sources (Nations et al. 2009). Calling rates decreased when exposed to seismic air guns at received levels of 116 to 129 dB re 1 μPa (possibly but not knowingly due to whale movement away from the air guns), but did not change at received levels of 99 to 108 dB re 1 μPa (Blackwell 2013). Despite the above information and exposure to repeated seismic surveys, bowheads continue to return to summer feeding areas and when displaced, appear to reoccupy areas within a day (Richardson et al. 1986). We do not know whether the individuals exposed in these ensonified areas are the same returning or whether individuals that tolerate repeat exposures may still experience a stress response. However, we expect that the presence of the protected species' observers and the shutdown that would occur if a whale were present in the exclusion zone would lower the likelihood that whales would be exposed to the airgun array.

Gray whales respond similarly. Gray whales discontinued feeding and/or moved away at received sound levels of 163 dB re 1 μPa_{rms} (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007b; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986; Malme et al. 1988; Würsig et al. 1999; Yazvenko et al. 2007a; Yazvenko et al. 2007b). Migrating gray whales began to show changes in swimming patterns at approximately 160 dB re 1 μPa and slight behavioral changes at 140 to 160 dB re 1 μPa_{rms} (Malme and Miles 1985; Malme et al. 1984). As with bowheads, habitat continues to be used despite frequent seismic survey activity, and long-term effects have not been identified, if they are present at all (Malme et al. 1984). Johnson et al. (2007a) reported that gray whales exposed to seismic air guns off Sakhalin Island, Russia, did not experience any biologically significant or population level effects, based on subsequent research in the area from 2002 to 2005. The seismic survey in that study took place between August 17 and September 9, 2001, a survey a little shorter than the proposed action.

Observational data are sparse for specific baleen whale life histories (breeding and feeding grounds) in response to air guns. Available data support a general avoidance response. Some fin and sei whale sighting data indicate similar sighting rates during seismic versus non-seismic periods, but sightings tended to be further away and individuals remained underwater longer (Stone 2003; Stone and Tasker 2006). Other studies have found at least small differences in sighting rates (lower during seismic activities) as well as whales being more distant during seismic operations (Moulton et al. 2006a; Moulton et al. 2006b; Moulton and Miller 2005). When spotted at the average sighting distance, individuals would have likely been exposed to approximately 169 dB re 1 μPa$_{\mathrm{rms}}$ (Moulton and Miller 2005).

Sperm whale response to air guns has thus far included mild behavioral disturbance (temporarily disrupted foraging, avoidance, cessation of vocal behavior) or no reaction. Several studies have found Atlantic sperm whales to show little or no response (Davis et al. 2000; Madsen et al. 2006; Miller et al. 2009; Moulton et al. 2006a; Moulton and Miller 2005; Stone 2003; Stone and Tasker 2006; Weir 2008). Detailed study of Gulf of Mexico sperm whales suggests some alteration in foraging from less than 130 to 162 dB re 1 μPa$_{\mathrm{p-p}}$, although other behavioral reactions were not noted by several authors (Gordon et al. 2006; Gordon et al. 2004; Jochens et al. 2006; Madsen et al. 2006; Winsor and Mate 2006). This has been contradicted by other studies, which found avoidance reactions by sperm whales in the Gulf of Mexico in response to seismic ensonification (Jochens and Biggs 2004; Jochens 2003; Mate et al. 1994). Johnson and Miller (2002) noted possible avoidance at received sound levels of 137 dB re 1 μPa. Other anthropogenic sounds, such as pingers and sonars, disrupt behavior and vocal patterns (Goold 1999; Watkins et al. 1985; Watkins and Schevill 1975). Miller et al. (2009) found sperm whales to be generally unresponsive to air gun exposure in the Gulf of Mexico, with possible but inconsistent responses that included delayed foraging and altered vocal behavior. Displacement from the area was not observed. Winsor and Mate (2013) did not find a nonrandom distribution of satellite-tagged sperm whales at and beyond 5 km from seismic air gun arrays, suggesting individuals were not displaced or move away from the array at and beyond these distances in the Gulf of Mexico (Mate 2013). However, no tagged whales within 5 km were available to assess potential displacement within 5 km (Mate 2013). The lack of response by this species may in part be due to its higher range of hearing sensitivity and the low-frequency (generally less than 188 Hz) pulses produced by seismic air guns (Richardson et al. 1995c). 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 at higher frequencies, this does not mean that it cannot hear air gun 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. Another odontocete, bottlenose dolphins, progressively reduced their vocalizations as an air gun array came closer and got louder (Woude 2013). Reactions to impulse noise 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 noise pulses (NMFS 2006b).

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

Marine mammals and physical or physiological effects. Individual whales exposed to air guns (as well as other sound sources) could experience effects not readily observable, such as stress, that can significantly affect life history. Other effects like neurological effects, bubble formation, and other types of organ or tissue damage could occur, but similar to stress, these effects are not readily observable.

Stress is an adaptive response and does not normally place an animal at risk. Distress involves a stress response resulting in a biological consequence to the individual. The mammalian stress response involves the hypothalamic-pituitary-adrenal axis being stimulated by a stressor, causing a cascade of physiological responses, such as the release of the stress hormones cortisol, adrenaline (epinephrine), glucocorticosteroids, and others (Busch 2009; Gregory 2001; Gulland 1999; St. Aubin 1988; St. Aubin 1996; Thomson 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 2009; Cattet 2003; Dickens 2010; Dierauf 2001; Elftman 2007; Fonfara 2007; Kaufman 1994; Mancia 2008; Noda 2007; Thomson 1986). In some species, stress can also increase an individual's susceptibility to gastrointestinal parasitism (Greer 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 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). Mammalian stress levels can vary by age, sex, season, and health status (Gardiner 1997; Hunt 2006; Keay 2006; Romero et al. 2008; St. Aubin 1996). Stress is lower in immature right whales than adults are and mammals with poor diets or undergoing dietary change tend to have higher fecal cortisol levels (Hunt 2006; Keay 2006).

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

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

It is possible that an animal's prior exposure to seismic sounds influences its future response. We have little information available to us as to what response individuals would have to future exposures to seismic sources compared to prior experience. If prior exposure produces a learned response, then this subsequent learned response would likely be similar to or less than prior responses to other stressors where the individual experienced a stress response associated with the novel stimuli and responded behaviorally as a consequence (such as moving away and reduced time budget for activities otherwise undertaken) (Andre 1997; André 1997; Gordon et al. 2006). We do not believe sensitization would occur based upon the lack of severe responses previously observed in marine mammals and sea turtles exposed to seismic sounds that would be expected to produce a more intense, frequent, and/or earlier response to subsequent exposures (see *Response Analysis*). The proposed action will take place over a little more than 30 days; minimizing the likelihood that sensitization would occur. As stated before, we believe that exposed individuals would move away from the sound source, especially in the open ocean of the action area, where we expect species to be transiting through.

Marine mammals and strandings. There is some concern regarding the coincidence of marine mammal strandings and proximal seismic surveys. No conclusive evidence exists to causally link stranding events to seismic surveys.

Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil 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, 8,490-in3 air gun array 22 km offshore the general area at the time that strandings occurred. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth, 2002; Yoder, 2002) as some vacationing marine mammal researchers who happened upon the stranding were ill-equipped to perform an adequate necropsy. Furthermore, the small numbers of animals involved and the lack of knowledge regarding the spatial and temporal correlation between the beaked whales and the sound source underlies the uncertainty regarding the linkage between seismic sound sources and beaked whale strandings (Cox 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 2000; Kerby 2004; Moberg 2000; Relyea 2005; Romero 2004). At present, the factors of seismic air guns that may contribute to marine mammal strandings are unknown and we have no evidence to lead us to believe that aspects of the air gun array proposed to for use will cause marine mammal strandings. We do not expect listed whales to strand because of the proposed seismic survey. The survey would take place in the middle of the Atlantic Ocean, near the Mid-Atlantic Ridge, thousands of kilometers from shore. If exposed to the seismic activities, we expect that ESA-listed whales would have sufficient space in the open ocean to move away from the sound and would not be likely to strand.

Responses of marine mammal prey. Seismic surveys may also have indirect, adverse effects on prey availability through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for listed whales. Unfortunately, species-specific information on the prey of listed whales and pinnipeds is not generally available. Until information that is more specific is available, we expect teleost, cephalopod, and krill prey of listed whales will react in manners similar to those fish and invertebrates described herein.

Some support has been found for fish or invertebrate mortality resulting from air gun exposure, and this is limited to close-range exposure to high-amplitudes (Bjarti 2002; D'Amelio 1999; Falk and Lawrence 1973; Hassel et al. 2003; Holliday et al. 1987; Kostyuchenko 1973; La Bella et al.

1996; McCauley et al. 2000a; McCauley et al. 2000b; McCauley et al. 2003; Popper et al. 2005). Lethal effects, if any, are expected within a few meters of the air gun array (Buchanan et al. 2004; Dalen and Knutsen 1986). We expect fish to be capable of moving away from the air gun array if it causes them discomfort.

More evidence exists for sub-lethal effects. Several species at various life stages have been exposed to high-intensity sound sources (220 to 242 dB re 1 μPa) at close distances, with some cases of injury (Booman et al. 1996; McCauley et al. 2003). Effects from TTS were not found in whitefish at received levels of approximately 175 dB re 1 $\mu Pa^2 \cdot s$, but pike did show 10 to 15 dB of hearing loss with recovery within 1 day (Popper et al. 2005). Caged pink snapper have experienced PTS when exposed over 600 times to seismic sound levels of 165 to 209 dB re 1 $\mu Pa_{p\text{-}p}$. Exposure to air guns at close range was found to produce balance issues in exposed fry (Dalen and Knutsen 1986). Exposure of monkfish and capelin eggs at close range to air guns did not produce differences in mortality compared to control groups (Payne 2009). Salmonid swim bladders were reportedly damaged by received sound levels of approximately 230 dB re 1 μPa (Falk and Lawrence 1973).

By far the most common response by fishes is a startle or distributional response, where fish react quickly by changing orientation or swimming speed, or change their vertical distribution in the water column. Although received sound levels were not reported, caged *Pelates* spp., pink snapper, and trevally generally exhibited startle, displacement, and/or grouping responses upon exposure to air guns (Fewtrell 2013a). This effect generally persisted for several minutes, although subsequent exposures of the same individuals did not necessarily elicit a response (Fewtrell 2013a). Startle responses were observed in rockfish at received air gun levels of 200 dB re 1 $\mu Pa_{0\text{-}p}$ and alarm responses at greater than 177 dB re 1 $\mu Pa_{0\text{-}p}$ (Pearson et al. 1992). Fish also tightened schools and shifted their distribution downward. Normal position and behavior resumed 20 to 60 minutes after seismic firing ceased. A downward shift was also noted by Skalski et al. (1992) at received seismic sounds of 186 to 191 re 1 $\mu Pa_{0\text{-}p}$. Caged European sea bass showed elevated stress levels when exposed to air guns, but levels returned to normal after 3 days (Skalski 1992). These fish also showed a startle response when the survey vessel was as much as 2.5 km away; this response increased in severity as the vessel approached and sound levels increased, but returned to normal after about 2-hours following cessation of air gun activity. Whiting exhibited a downward distributional shift upon exposure to 178 dB re 1 $\mu Pa_{0\text{-}p}$ air gun sound, but habituated to the sound after 1 hour and returned to normal depth (sound environments of 185 to192 dB re 1 μPa) despite air gun activity (Chapman and Hawkins 1969). Whiting may also flee from air gun sound (Dalen and Knutsen 1986). Hake may redistribute downward (La Bella et al. 1996). Lesser sand eels exhibited initial startle responses and upward vertical movements before fleeing from the survey area upon approach of an active seismic vessel (Hassel et al. 2003; Hassel et al. 2004). McCauley et al. (2000; 2000a) found smaller fish show startle responses at lower levels than larger fish in a variety of fish species and generally observed responses at received sound levels of 156 to 161 dB re 1 μPa_{rms}, but responses tended to decrease over time suggesting habituation. As with previous studies, caged fish showed increases in swimming speeds and downward vertical shifts. Pollock did not respond to air gun sounds received at 195 to 218 dB re 1 $\mu Pa_{0\text{-}p}$, but did exhibit continual startle responses and fled from the seismic source when visible (Wardle et al. 2001). Blue whiting and mesopelagic fishes were found to redistribute 20 to 50 meters deeper in response to air gun ensonification and a shift away from the survey area was also found (Slotte et al. 2004). Startle responses were infrequently observed from salmonids receiving 142 to 186 dB re 1 $\mu Pa_{p\text{-}p}$ sound levels from an air gun (Thomsen 2002). Cod and haddock likely vacate seismic survey areas in response to air gun activity and estimated catchability decreased starting at received sound levels of 160 to 180 dB re 1 $\mu Pa_{0\text{-}p}$ (Dalen and Knutsen 1986; Engås et al. 1996; Engås et al. 1993; Løkkeborg 1991; Løkkeborg and Soldal 1993; Turnpenny et al. 1994). Increased swimming activity in response to air gun exposure, as well as reduced foraging activity, is supported by data collected by Lokkeborg et al. (2012). Bass did not appear to vacate during a shallow-water seismic survey with received sound levels of 163 to 191 dB re 1 $\mu Pa_{0\text{-}p}$ (Turnpenny and Nedwell 1994). Similarly, European sea bass apparently did not leave their inshore habitat during a 4 to 5 month seismic survey (Pickett et al. 1994). La Bella et al. (1996) found no differences in trawl catch data before and after seismic operations and echosurveys of fish occurrence did not reveal differences in pelagic biomass. However, fish kept in cages did show behavioral responses to approaching air guns.

Squid responses to air guns have also been studied, although to a lesser extent than fishes. In response to air gun exposure, squid exhibited both startle and avoidance responses at received sound levels of 174 dB re 1 μPa_{rms} by first ejecting ink and then moving rapidly away from the area (Fewtrell 2013b; McCauley et al. 2000a; McCauley et al. 2000b). The authors also noted some movement upward. During ramp-up, squid did not discharge ink but alarm responses occurred when received sound levels reached 156 to 161 dB re 1 μPa_{rms}. Tenera Environmental (2011) reported that Norris and Mohl (1983, summarized in Mariyasu et al. 2004) observed lethal effects in squid (*Loligo vulgaris*) at levels of 246 to 252 dB after 3 to 11 minutes. André (2011) exposed four cephalopod species (*Loligo vulgaris*, *Sepia officinalis*, *Octopus vulgaris*, and *Ilex coindetii*) to 2-hours of continuous sound from 50 to 400 Hz at 157 plus or minus 5 dB re 1 μPa. They reported lesions to the sensory hair cells of the statocysts of the exposed animals that increased in severity with time, suggesting that cephalopods are particularly sensitive to low-frequency sound. The received sound pressure level was 157 plus or minus 5 dB re 1 μPa, with peak levels at 175 dB re 1 μPa. Guerra et al. (2004) suggested that giant squid mortalities were associated with seismic surveys based upon coincidence of carcasses with the surveys in time and space, as well as pathological information from the carcasses. Another laboratory story observed abnormalities in larval scallops after exposure to low frequency noise in tanks (de Soto et al. 2013). Lobsters did not exhibit delayed mortality, or apparent damage to mechanobalancing systems after up to 8 months post-exposure to air guns fired at 202 or 227 dB peak-to-peak pressure (Christian 2013). However, feeding did increase in exposed individuals (Christian 2013).

The overall response of fishes and squids is to exhibit startle responses and undergo vertical and horizontal movements away from the sound field. We do not expect krill (the primary prey of most listed baleen whales) to experience effects from air gun sound. Therefore, we do not expect any adverse effects from lack of prey availability to baleen whales. Sperm whales regularly feed on squid and some fishes and we expect individuals to feed while in the action area during the proposed survey. Based upon the best available information, fishes and squids ensonified by the approximately 160 dB isopleths could vacate the area and/or dive to greater depths, and be more alert for predators. We do not expect indirect effects from air gun activities through reduced feeding opportunities for listed whales and pinnipeds to be sufficient to reach a significant level. Effects are likely to be temporary and, if displaced, both sperm whales and their prey would re-distribute back into the area once survey activities have passed.

Marine mammal response to multibeam echosounder and sub-bottom profiler. We expect listed whales to experience ensonification from not only air guns, but also seafloor and ocean current mapping systems. The multibeam echosounder and sub-bottom profiler used in this survey operate at frequencies of 10.5 to 13 kHz, and 3.5 kHz, respectively. These frequencies are within the functional hearing range of baleen whales, such as the ESA-listed blue, fin and sei whales.[2] We expect that these mapping systems will produce harmonic components in a frequency range above and below the center frequency similar to other commercial sonars (Deng 2014). Although 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 source was a signal designed to be alarming and the sound level was well below typical ambient noise. Goldbogen et al. (2013) found blue whales to respond to 3.5 to 4.0 kHz mid-frequency sonar at received levels below 90 dB re 1 μPa. Responses included cessation of foraging, increased swimming speed, and directed travel away from the source (Goldbogen 2013). Hearing is poorly understood for listed baleen whales, but it is assumed that they are most sensitive to frequencies over which they vocalize, which are much lower than frequencies emitted by the multibeam echosounder and sub-bottom profiler systems (Ketten 1997; Oleson 2007; Richardson et al. 1995c).

Assumptions for sperm whale hearing are much different from other listed whales. Sperm whales vocalize between 3.5 to 12.6 kHz and an audiogram of a juvenile sperm whale provides direct support for hearing over this entire range (Au 2000a; Au et al. 2006; Carder and Ridgway 1990; Erbe 2002a; Frazer and Mercado 2000; Goold and Jones 1995; Levenson 1974; Payne and Payne 1985; Payne 1970; Richardson et al. 1995c; Silber 1986; Thompson et al. 1986; Tyack 1983; Tyack and Whitehead 1983; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997; Weir et al. 2007; Winn et al. 1970). The response of a blue whale to 3.5 kHz sonar supports this species ability to hear this signal as well (Goldbogen 2013). Maybaum (1990; 1993) observed that Hawaiian humpbacks moved away and/or increased swimming speed upon exposure to 3.1

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[2] http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

to 3.6 kHz sonar. Kremser et al. (2005) concluded the probability of a cetacean swimming through the area of exposure when such sources emit a pulse is small, as the animal would have to pass at close range and be swimming at speeds similar to the vessel. The animal would have to pass the transducer at close range and be swimming at speeds similar to the vessel in order to receive the multiple pulses that might result in sufficient exposure to cause TTS. 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 (Andre 1997; André 1997).

Investigations stemming from a 2008 stranding event in Madagascar indicated a 12 kHz multibeam echosounder, similar in operating characteristics as that proposed for use aboard the *Atlantis,* suggest that this sonar played a significant role in the mass stranding of a large group of melon-headed whales (*Peponocephala electra*) (Southall 2013). Although pathological data to suggest a direct physical affect are lacking and the authors acknowledge that although the use of this type of sonar is widespread and common place globally without noted incidents like the Madagascar stranding, all other possibilities were either ruled out or believed to be of much lower likelihood as a cause or contributor to stranding compared to the use of the multibeam echosounder (Southall 2013). This incident highlights the caution needed when interpreting effects that may or may not stem from anthropogenic sound sources, such as the *Atlantis*' multibeam echosounder. Although effects such as this have not been documented for ESA-listed species, or in NSF's reports for previous surveys, the combination of exposure to this stressor with other factors, such as behavioral and reproductive state, oceanographic and bathymetric conditions, movement of the source, previous experience of individuals with the stressor, and other factors may combine to produce a response that is greater than would otherwise be anticipated or has been documented to date (Ellison et al. 2012; Francis 2013).

Stranding events associated with the operation of naval sonar suggest that mid-frequency sonar sounds may have the capacity to cause serious impacts to marine mammals. The sonars proposed for use by Scripps Institution of Oceanography differ from sonars used during naval operations, which generally have a longer pulse duration and more horizontal orientation than the more downward-directed multibeam echosounder and sub-bottom profiler. The sound energy received by any individuals exposed to the multibeam echosounder and sub-bottom profiler sources during the proposed activities is lower relative to naval sonars, as is the duration of exposure. The area of possible influence for the multibeam echosounder and sub-bottom profiler is also much smaller, consisting of a narrow zone close to and below the source vessel. Although thousands of vessels around the world operate navigational sonars routinely, strandings have not been correlated to use of these sonars. Because of these differences, we do not expect these systems to contribute to a stranding event.

We do not expect masking of blue, fin, sei, or sperm whale communications to appreciably occur due to multibeam echosounder or sub-bottom profiler signal directionality, low duty cycle, and the brief period when an individual could be within its beam. These factors were considered when Burkhardt et al. (2013) estimated the risk of injury from multibeam echosounder was less than 3 percent that of vessel strike. Behavioral responses to the multibeam echosounder and sub-bottom profiler are likely to be similar to the other pulsed sources discussed earlier if received at the same levels. However, the pulsed signals from the sub-bottom profiler are considerably weaker than those from the multibeam echosounder. In addition, we do not expect hearing impairment and other physical effects if the animal is in the area, and it would have to pass the transducers at close range and in order to be subjected to sound levels that could cause temporary threshold shift.

10.3.3.2 Potential responses of ESA-listed sea turtles to acoustic sources

As with marine mammals, ESA-listed sea turtles may experience:

- Hearing threshold shifts,
- Behavioral responses and
- Non-auditory physical or physiological effects.

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 because they are not known to rely heavily on acoustics for life functions (Nelms et al. 2016; Popper et al. 2014b).

Sea turtles and threshold shifts. Although sea turtles detect low frequency sound, the potential effects on sea turtle biology remain largely unknown (Samuel et al. 2005). Few data are available to assess sea turtle hearing, let alone the effects seismic equipment may have on their hearing potential. The only study which addressed sea turtle TTS was conducted by Moein et al. (1994), in which a loggerhead experienced TTS upon multiple air gun exposures in a shallow water enclosure, but recovered within 1 day.

As with marine mammals, we assume that sea turtles will not move towards a source of stress or discomfort. Some experimental data suggest sea turtles may avoid seismic sources (McCauley et al. 2000a; McCauley et al. 2000b; Moein et al. 1994), but monitoring reports from seismic surveys in other regions suggest that some sea turtles do not avoid air guns and were likely exposed to higher levels of seismic air gun pulses (Smultea and Holst 2003). For this reason, mitigation measures are also in place to limit sea turtle exposure. Although data on the precise levels that can result in TTS or PTS are lacking, because of the mitigation measures and our expectation that turtles would move away from sounds from the air gun array, we do not expect turtles to be exposed to sound levels that would result in TTS or PTS.

Sea turtles and behavioral responses. As with ESA-listed marine mammals, it is likely that sea turtles will experience behavioral responses in the form of avoidance. We do not have much information on how sea turtles specifically will respond, but we present the available information. O’Hara and Wilcox (1990a) found loggerhead sea turtles exhibited an avoidance reaction at an estimated sound level of 175 to 176 dB re 1 μPa$_{rms}$ (or slightly less) in a shallow canal. Green and loggerhead sea turtles avoided air gun sounds at received sound levels of 166 dB re 1 μPa and 175 dB re 1 μPa, respectively (McCauley et al. 2000a; McCauley et al. 2000b). Sea turtle swimming speed increased and becomes more erratic at 175 dB re 1 μPa, with individuals becoming agitated. Loggerheads also appeared to move towards the surface upon air gun exposure (Lenhardt 1994; Lenhardt et al. 1983). However, loggerheads resting at the ocean surface were observed to startle and dive as active seismic source approached them (DeRuiter 2012). Responses decreased with increasing distance of closest approach by the seismic array (DeRuiter 2012). The authors developed a response curve based upon observed responses and predicted received exposure level. Recent monitoring studies show that some sea turtles move away from approaching air guns, although sea turtles may approach active seismic arrays within 10-meters (Holst 2006; LGL Ltd 2005a; LGL Ltd 2005b; LGL Ltd 2008; NMFS 2006e; NMFS 2006h).

A sea turtle's behavioral responses to sound are assumed variable and context specific. For instance, a single impulse may cause a brief startle reaction. A sea turtle may swim farther away from the sound source, increase swimming speed, change surfacing time, and decrease foraging if the stressor continues to occur. For each potential behavioral change, the magnitude of the change ultimately would determine the severity of the response; most responses would be short-term avoidance reactions.

Some studies have investigated behavioral responses of sea turtles to impulsive sounds emitted by air guns (McCauley 2000; Moein Bartol 1995; O'Hara 1990). There are no studies of sea turtle behavioral responses to sonar. Cumulatively, available air gun studies indicate that perception and a behavioral reaction to a repeated sound may occur with sound pressure levels greater than 166 dB re 1 μPa root mean square, and that more erratic behavior and avoidance may occur at higher thresholds around 175 to 179 dB re 1 μPa root mean square (McCauley 2000; Moein Bartol 1995; O'Hara 1990). When exposed to impulsive acoustic energy from an air gun above 175 dB re 1 μPa root mean square, sea turtle behavior becomes more erratic, possibly indicating the turtles were in an agitated state (McCauley et al. 2000). A received level of 175 dB re 1 μPa root mean square is more likely to be the point at which avoidance may occur in unrestrained turtles, with a comparable sound exposure level of 160 dB re 1 μPa2 -s (McCauley 2000). Air gun studies used sources that fired repeatedly over some duration. For single impulses at received levels below threshold shift (hearing loss) levels, the most likely behavioral response is assumed to be a startle response. Since no further sounds follow the initial brief impulse, the biological significance is considered minimal.

Behavioral responses of sea turtles to air gun exposures in caged enclosures are likely to be different from those from turtles exposed to impulsive acoustic sources from seismic activities in the open environment. Although information regarding the behavioral response of sea turtles to acoustic stressors is generally lacking, McCauley (2000) provides an indication that 175 dB re 1 μPa root mean square is a reasonable threshold criterion in the absence of more rigorous experimental or observational data. The 175 dB re 1 μPa root mean square threshold criterion for behavioral take in sea turtles may change with better available information in the future, but currently is the best available science. To assess the number of sea turtles expected to behaviorally respond to acoustic stress all turtles exposed to sound equal to, or greater than, 175 dB and less than the criterion for TTS were summed. No attempt to process these exposures or evaluate the effectiveness of mitigation measures was made, suggesting any behavioral take estimates of sea turtles from acoustic stressors are likely overestimates. We are unaware of any sea turtle response studies to non-impulsive acoustic energy; therefore, we used the same criteria as those for impulsive acoustic stressors.

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. At 175 dB re 1 μPa, we anticipate some change in swimming patterns and a stress response of exposed individuals. Some turtles may approach the active seismic array to closer proximity, but we expect them to eventually turn away. We expect temporary displacement of exposed individuals from some portions of the action area while the *Atlantis* transects through.

Sea turtles and stress. Direct evidence of seismic sound causing stress is lacking in sea turtles. However, we expect sea turtles to generally avoid high-intensity exposure to air guns in a fashion similar to predator avoidance. As predators generally induce a stress response in their prey (Dwyer 2004; Lopez 2001; Mateo 2007), we assume that sea turtles experience a stress response to air guns when they exhibit behavioral avoidance or when they are exposed to sound levels apparently sufficient to initiate an avoidance response (approximately 175 dB re 1 μPa). We expect breeding adult females may experience a lower stress response, as female loggerhead, hawksbill, and green sea turtles appear to have a physiological mechanism to reduce or eliminate hormonal response to stress (predator attack, high temperature, and capture) in order to maintain reproductive capacity at least during their breeding season; a mechanism apparently not shared with males (Jessop 2001; Jessop et al. 2000; Jessop et al. 2004). Individuals may experience a stress response at levels lower than approximately 175 dB re 1 μPa, but data are lacking to evaluate this possibility. Therefore, we follow the best available evidence identifying a behavioral response as the point at which we also expect a significant stress response.

Sea turtle response to multibeam echosounder and sub-bottom profiler. Sea turtles do not possess a hearing range that includes frequencies emitted by these systems. Therefore, listed sea turtles will not hear these sounds even if they are exposed and are not expected to respond to them.

10.4 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. For designated critical habitat, we assess the consequences of these responses on the value of the critical habitat for the conservation of the species for which the habitat had been designated.

We measure risks to individuals of endangered or threatened species using changes in the individual's fitness, which may be indicated by changes to the individual's growth, survival, annual reproductive fitness, and lifetime reproductive success. When we do not expect ESA-listed animals exposed to an action's effects to experience reductions in fitness, we would not expect the action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise.

We expect that up to 1 blue, 90 fin, 113 sei, and 451 sperm whales within the 578-meter (8-meter gun separation) or 539-meter (2-meter gun separation) areas during air gun operations to be exposed to noise from the air guns during the seismic survey. We expect that any leatherback, North Atlantic green, Northwest Atlantic Ocean loggerhead, or Northeast Atlantic Ocean loggerhead sea turtles within the 103-meter (8-meter gun separation) or 91-meter (2-meter gun separation) areas during air gun operations to be exposed to the air guns during the seismic survey.

Because of the mitigation measures in the IHA, and the relatively low-energy nature of the seismic survey, we do not expect any mortality to occur from the exposure. The proposed action will result in temporary stress to the exposed whales or sea turtles that is not expected to have more than short-term effects on individual blue, fin, sei, sperm whales, or leatherback, North Atlantic DPS green, Northeast Atlantic Ocean DPS or Northwest Atlantic Ocean DPS loggerhead sea turtles.

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 because of implementing the proposed action. In this section, we add the *Effects of the Action* (Section 10) to the *Environmental Baseline* (Section 9) and the *Cumulative Effects* to formulate the agency's biological opinion as to whether the proposed action is likely to 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. This assessment is made in full consideration of the *Status of the Species Likely to be Adversely Affected* (Section 8.1).

The following discussion summarizes the probable risks the proposed action poses to threatened and endangered species that are likely to be exposed to the stressors associated with the activities related to NSF's seismic research survey and the Permits and Conservation Division's issuance of an IHA. The summary integrates the exposure profiles presented previously with the results of our response analyses for each of the actions considered in this opinion.

11.1 Blue Whale

No reduction in the distribution of blue whales from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

There are three stocks of blue whales designated in U.S. waters: the Eastern North Pacific Ocean, the Central Pacific Ocean, and the Western North Atlantic Ocean. The Western North Atlantic stock is the stock we expect to be present in the action area. An overall population growth rate for the species or growth rates for the Western North Atlantic stock are not available at this time. 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.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of blue whales because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

The Final Recovery Plan for the blue whales lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Identify and protected habitat essential to the survival and recovery of blue whale populations.
- Reduce or eliminate human-caused injury and mortality of blue whales.
- Minimize detrimental effects of directed vessel interactions with blue whales.
- Maximize efforts to acquire scientific information from dead, stranded, and entangled blue whales.

Because no mortalities or effects on the distribution of blue whale populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives for blue whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of blue whales in the wild.

11.2 Fin Whale

No reduction in the distribution of fin whales from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

There are three to seven stocks of fin whale in the North Atlantic totaling approximately 50,000 individuals. The International Whaling Commission considers fin whales in the central North Atlantic and off West Greenland to be robust, at about 4,500 individuals, with another 1,600 in U.S. waters. There is some uncertainty in the total abundance estimates for fin whale stocks in the North Atlantic, in part owing to uncertainties in stock structure. Overall population growth rates for the North Atlantic stocks are not available at this time.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of fin whales because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

The 2010 Recovery Final Plan for fin whales identifies recovery goals for the species, including addressing significant threats to the species, and achieving sufficient and viable populations in all ocean basins.

Because no mortalities or effects on the distribution of fin whale populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives for fin whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of fin whales in the wild.

11.3 Sei Whale

No reduction in the distribution of sei whales from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

There are no population estimates for sei whales in the North Atlantic action area, although there are reports of sightings in the region. In a 2004 survey, sei whales were the most abundant whale species sighted (Waring et al. 2008). Population growth rates for sei whales are not available at this time.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of sei whales because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

The 2011 Final Recovery Plan for sei whales identifies recovery goals for the species, including addressing significant threats to the species, and achieving sufficient and viable populations in all ocean basins.

Because no mortalities or effects on the distribution of sei whale populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives for sei whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of sei whales in the wild.

11.4 Sperm Whale

No reduction in the distribution of sperm whales from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits, and Conservation Division's issuance of an IHA.

There are six recognized stocks of sperm whales in U.S. waters. Abundance for sperm whales in the North Atlantic is estimated at N=2,288 (and this is considered an underestimate). There is insufficient data to evaluate trends in abundance and growth rates of sperm whales in the North Atlantic at this time.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected because of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of sperm whales because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

The 2010 Final Recovery Plan for sperm whales identifies recovery goals for the species, including addressing significant threats to the species, and achieving sufficient and viable populations in all ocean basins.

Because no mortalities or effects on the distribution of sperm whale populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives for sperm whales. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of sperm whales in the wild.

11.5 Summary for ESA-listed Whales

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

11.6 Leatherback Sea Turtle

No reduction in the distribution of leatherback sea turtles from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

The Leatherback TEWG estimates there are between 34,000 to 95,000 total adults (20,000 to 56,000 adult females; 10,000 to 21,000 nesting females) in the North Atlantic. Of the five leatherback populations or groups of populations in the North Atlantic, three show an increasing or stable trend (Florida, Northern Caribbean, and Southern Caribbean). There is not enough information available on the West African population to conduct a trend analysis and a slight decline in annual population growth rate was detected for the Western Caribbean (TEWG 2007).

Because we do not anticipate a reduction in numbers or reproduction of leatherback turtles because of the proposed activities, a reduction in the species' likelihood of survival is not expected.

The Atlantic Recovery Plan for the U.S. population of leatherback sea turtles (NMFS and USFWS 1992) lists recovery objectives for the species. The following recovery objective is relevant to the impacts of the proposed action:

- The adult female population increases over the next 25 years, as evidenced by a statistically significant trend in the number of nests at Culebra, Puerto Rico; St. Croix, U.S. Virgin Islands; and along the east coast of Florida.

In Puerto Rico, the main nesting areas for leatherback sea turtles are in Fajardo on the main island and on the island of Culebra. Between 1978 and 2005, nesting increased from a minimum of 9 nests recorded in 1978 to 469-882 nests recorded each year between 2000 and 2005 throughout Puerto Rico. Reports from nesting in Fajardo in particular indicate that this increase in nesting has continued. In the U.S. Virgin Islands, researchers estimated a population growth of approximately 13 percent per year on Sandy Point Beach, St. Croix from 1994 through 2001. These numbers also continue increasing.

Because no mortalities or effects on the distribution of leatherback sea turtle populations are expected, we do not anticipate the proposed activities will impede the recovery objectives for leatherback sea turtles. In conclusion, we believe the effects associated with the proposed action are not expected to cause a reduction in the likelihood of survival and recovery of leatherback sea turtles in the wild.

11.7 North Atlantic DPS Green Sea Turtle

No reduction in the distribution of North Atlantic DPS green sea turtles from the Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

The 2007 5-year status review for green turtles states that of the seven green sea turtle nesting concentrations in the Atlantic Basin for which abundance trend is available, all were determined to be either stable or increasing (NMFS 2007). Additionally, the 2014 status review for green sea turtles, which also suggested possible DPSs, determined that there were over 167,000 nesting females in the North Atlantic DPS (NMFS and USFWS 2015). These estimates did not include multiple smaller sites for which nesting data were not available. All major nesting populations in the North Atlantic DPS demonstrate long-term increases in abundance (Seminoff et al. 2015). No reduction in numbers is anticipated as part of the proposed action.

Therefore, no reduction in reproduction is expected because of the proposed action. Because we do not anticipate a reduction in numbers or reproduction of leatherback sea turtles because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

The 1991 Recovery Plan for the Atlantic Green turtle contains several broad recovery objectives, including 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.

Because no mortalities or effects on the distribution of North Atlantic DPS green sea turtles populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives for North Atlantic DPS green sea turtles. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of North Atlantic DPS green sea turtles in the wild.

11.8 Northeast Atlantic Ocean and Northwest Atlantic Ocean DPS Loggerhead Sea Turtle

No reduction in the distribution of Northeast and Northwest Atlantic Ocean DPS loggerhead sea turtles from the North Atlantic Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

Using a stage/age demographic model, the adult female population size of the Northwest Atlantic Ocean DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS-SEFSC 2009). The population growth rates for each one of the recovery units within the DPS all exhibit negative growth rates. Loggerheads of the Northeast Atlantic Ocean DPS nest on the islands of the Cape Verde Archipelago, off the coast of western Africa. Boavista Island hosts the largest nesting aggregation, with over 10,000 nests annually, making it the third largest loggerhead nesting population in the world (Marco et al. 2010). There was not sufficient time series nesting data to calculate population growth rates for the Northeast Atlantic Ocean DPS.

NMFS has not developed a Recovery Plan for the Northeast Atlantic Ocean DPS loggerhead sea turtle. The 2009 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads lists recovery plans for this DPS. The following recovery objective is relevant to the impacts of the proposed action:

- Manage sufficient feeding, migratory, and inter-nesting marine habitats to ensure successful growth and reproduction.
- Minimize vessel strike mortality.

Because no mortalities or effects on the distribution of Northwest Atlantic Ocean DPS loggerhead populations are expected because of the proposed actions, we do not anticipate the proposed actions will impede the recovery objectives. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the likelihood of survival and recovery of either loggerhead DPS in the wild.

11.9 Summary for ESA-listed Sea Turtles

We expect exposed leatherback, loggerhead, and green sea turtles to experience some degree of stress response upon exposure the air guns. We also expect many of these individuals to respond behaviorally by exhibiting a startle response or by swimming away. We do not expect more than temporary displacement or removal of individuals for a period of hours from small areas because of the proposed actions. Individuals responding in such ways may temporarily cease feeding, breeding, resting, or otherwise disrupt vital activities. However, we do not expect that these disruptions will cause a measureable impact to any individual's growth or reproduction. Overall, we do not expect any population to experience a fitness consequence because of the proposed actions and, by extension, do not expect species-level effects.

12 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.

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 9), which we expect will continue in the future. Anthropogenic effects include climate change, vessel strikes, sound, military activities, fisheries, pollution, and scientific research, although some of these activities would involve a federal nexus and thus, but subject to future ESA section 7 consultation. An increase in these activities could result in an increased effect on ESA-listed species; however, the magnitude and significance of any anticipated effects remain unknown at this time. The best scientific and commercial data available provide little specific information on any long-term effects of these potential sources of disturbance on ESA-listed whale or sea turtle populations.

13 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 NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of blue, fin, sei, and sperm whales, or leatherback, North Atlantic Ocean DPS green, Northeast Atlantic Ocean DPS and Northwest Atlantic Ocean DPS loggerhead sea turtles.

14 INCIDENTAL TAKE STATEMENT

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 take of endangered or threatened species. 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. 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, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

NMFS also must provide reasonable and prudent measures that are necessary or appropriate to minimize the impacts to the species, and terms and conditions to implement the measures. Section 7(o)(2) provides that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited under section 9(a) the ESA and regulations issued pursuant to section 4(d) if that action is performed in compliance with the terms and conditions of this incidental take statement.

14.1 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.

If the amount or location of track line surveyed changes, or the number of survey days is increased, then incidental take for marine mammals and sea turtles may be exceeded. As such, if more track lines are surveyed, an increase in the number of survey days beyond the 25 percent contingency, greater estimates of sound propagation, and/or increases in air gun source levels occur, re-initiation of consultation will be necessary.

14.1.1 Whales

The NMFS anticipates the proposed seismic survey in the Mid-Atlantic Ocean over the Mid-Atlantic Ridge is likely to result in the non-lethal take of ESA-listed marine mammals by harassment (Table 7) as defined under MMPA and adopted here to represent non-lethal exposure. We expect up to 1 blue, 90 fin, 113 sei, and 451 individual sperm whales could be exposed to air gun sounds during the course of the proposed seismic survey, which will elicit a behavioral response that would constitute harassment. Behavioral (MMPA Level B) harassment is expected to occur at received levels at or above 160 dB re: 1 µPa (rms) for ESA-listed marine mammals.

For all species of marine mammals, this incidental take would result from exposure to acoustic energy during seismic operations and would be in the form of harassment, and is not expected to result in the death or injury of any individuals that are exposed.

Table 7. Amount of anticipated take of ESA-listed marine mammals

Species	Number of Individuals
Blue whale	1
Fin whale	90

Species	Number of Individuals
Sei whale	113
Sperm whale	451

14.1.2 Sea Turtles

We also expect individual leatherback, North Atlantic DPS green, Northeast Atlantic Ocean DPS, and Northwest Atlantic Ocean DPS loggerhead sea turtles could be exposed to air gun sounds during the course of the proposed seismic survey that will elicit a behavioral response that would constitute harassment. No death or injury is expected for individual sea turtles who are exposed to the seismic activities.

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 or habitat or ecological conditions) may be used to express the amount or extent of anticipated take.

Because there are no reliable estimates of sea turtle population density in the action area, it is not practical to develop numerical estimates of sea turtle exposure. We are relying on the extent of the 175 dB exclusion zone as a surrogate for sea turtle take. Harassment for sea turtles is expected to occur at received levels above 175 dB re 1 μPa, which includes a 0.033 km^2 area (8-meter gun separation) or 0.026 km^2 area (2-meter gun separation) in the northern Atlantic Ocean based upon the propagation and track line estimates provided by the NSF. A sea turtle within the 0.033 or 0.026 km^2 area during air gun operations would be affected by the stressor, and is expected to respond in a manner that constitutes take in the form of harassment.

The extent of the ensonified area is calculated based on the number of air guns used during seismic operations, the tow depth of the air gun array, and the depth of the water in the action area. The tow depth and the water depth can change the predicted distances to which sound levels 175 dB re 1 μPa are received, so we are assuming the largest predicted established distance of 0.033 or 0.026 km^2 for the 175 dB exclusion zone so as not to underestimate the effect of the stressor. As we cannot determine the number of individuals to which harassment will occur, we expect the extent of exposure will occur within the 175 dB isopleth of the *Atlantis'* air gun array.

14.2 Effects of the Take

In this opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

14.3 Reasonable and Prudent Measures

NMFS believes the reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

- The NMFS’ Permits and Conservation Division and the NSF must ensure that the Scripps Institution of Oceanography implements and monitors the effectiveness of mitigation measures incorporated as part of the proposed authorization of the incidental taking of blue, fin, sei, humpback, and sperm whales pursuant to the IHA and as specified below for sea turtles. In addition, the NMFS’ Permits and Conservation Division must ensure that the provisions of the IHA are carried out, and to inform the NMFS’ ESA Interagency Cooperation Division if take is exceeded.
- The NMFS' Permits and Conservation Division shall require that the NSF and the Scripps Institution of Oceanography implement a program to monitor potential interactions between seismic survey activities and threatened and endangered species of marine mammals and sea turtles.

14.4 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA and regulations issued pursuant to section 4(d), the NSF, Scripps Institution of Oceanography, and NMFS’ Permits and Conservation Division must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. The terms and conditions described below are nondiscretionary, and must be undertaken by NSF, Scripps Institution of Oceanography, and the Permits and Conservation Division so that they become binding conditions for the exemption in section 7(o)(2) to apply.

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 the NSF, Scripps Institution of Oceanography, and NMFS’ Permits and Conservation Division fail to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

To implement the reasonable and prudent measures, the Scripps Institution of Oceanography, and the NMFS’ Permits and Conservation Division shall ensure the conditions listed in this section.

1. A copy of the draft comprehensive report on all activities and monitoring results must be provided to the ESA Interagency Cooperation Division within 90 days of the completion of the survey, or expiration of the IHA, whichever comes sooner.
2. Any reports of injured or dead ESA-listed species must be provided to the ESA Interagency Cooperation Division immediately to Cathryn Tortorici, Chief, ESA Interagency Cooperation Division by e-mail at cathy.tortorici@noaa.gov.

15 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 recommend the following conservation recommendations, which would provide information for future consultations involving seismic surveys and the issuance of Incidental Harassment Authorizations that may affect endangered large whales and endangered or threatened sea turtles.

1. The NSF should promote and fund research examining the potential effects of seismic surveys on ESA-listed sea turtles and fishes.
2. The NSF should develop a more robust propagation model that incorporates environmental variables into estimates of how far sound levels reach from air gun sources.

In order for NMFS' Office of Protected Resources Endangered Species Act Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the NMFS' Permits and Conservation Division should notify the Endangered Species Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

16 REINITIATION NOTICE

This concludes formal consultation for the NSF and the NMFS Permits and Conservation Division. 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.

17 APPENDIX A: INCIDENTAL HARASSMENT AUTHORIZATION CONDITIONS

The Permits and Conservation Division proposes to include the following requirements that Scripps Institution of Oceanography must comply with as part of the IHA. The text below was taken directly from the proposed permit provided to us in the consultation initiation package.

1. This 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 the Scripps Institution of Oceanography's IHA application and using an air gun array aboard the *Atlantis* with characteristics specified in the application, in the northeast Pacific Ocean.
3. General Conditions
    a. A copy of the IHA must be in the possession of Scripps Institution of Oceanography, the vessel operator and other relevant personnel, the lead protected species observer (PSO), and any other relevant designees of Scripps Institution of Oceanography operating under the authority of the IHA.

    b. The species authorized for taking are listed in Table 8 of the IHA[3]. The taking, by harassment only, is limited to the species and numbers listed in Table 8 of the IHA. Any taking exceeding the authorized amounts listed in Table 8 of the IHA is prohibited and may result in the modification, suspension, or revocation of the IHA.

    c. The taking by serious injury or death of any species of marine mammal is prohibited and may result in the modification, suspension, or revocation of the IHA.

    d. During use of the air gun(s), if marine mammal species other than those listed in Table 8 of the IHA are detected by PSOs, the acoustic source must be shut down to avoid unauthorized take.

    e. Scripps Institution of Oceanography 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.
4. Mitigation Requirements
    a. Scripps Institution of Oceanography must use at least three (3) dedicated, trained, NMFS-approved PSOs. The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and

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[3] Table 8 in the IHA contains ESA-listed marine mammals as well as non-listed marine mammals. For the ESA-listed marine mammals authorized for taking under the IHA, see Table 7.

instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements. PSO resumes shall be provided to NMFS for approval.

b. At least one PSO must have 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. One "experienced" visual PSO shall be designated as the lead for the entire protected species observation team. The lead PSO shall serve as primary point of contact for the vessel operator.

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), typically two, and minimally one, PSO(s) 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).

    ii. Visual monitoring must begin not less than 30 minutes prior to ramp-up, including for nighttime ramp-ups of the air gun array, and must continue until one hour after use of the acoustic source ceases or until 30 minutes past sunset.

    iii. 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. PSOs may be on watch for a maximum of four 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.

    v. During good conditions (e.g., daylight hours; Beaufort sea state 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. Exclusion Zone and buffer zone – PSOs shall establish and monitor a 100-meter exclusion zone (EZ) and 200 meter buffer zone. The zones shall be based upon radial distance from any element of the air gun 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 outside the EZ but within 200 meters from any element of the air gun array shall be communicated to the operator to prepare for potential further mitigation measures as described below. During use of the acoustic source, occurrence of marine mammals within the EZ, or on a course to enter the EZ, shall trigger further mitigation measures as described below.

i. Ramp-up – A ramp-up procedure is required at all times as part of the activation of the acoustic source. Ramp-up would begin with one 45-in^3 air gun, and the second 45-in^3 air gun would be added after 5 minutes.

ii. If the air gun array has been shut down due to a marine mammal detection, ramp-up shall not occur until all marine mammals have cleared the EZ. A marine mammal is considered to have cleared the EZ if:
    1. It has been visually observed to have left the EZ; or
    2. It has not been observed within the EZ, for 15 minutes (in the case of small odontocetes) or for 30 minutes (in the case of mysticetes and large odontocetes including sperm, pygmy sperm, and beaked whales).

iii. Thirty minutes of pre-clearance observation of the 100-meter EZ and 200-meter buffer zone are required prior to ramp-up for any shutdown of longer than 30 minutes. This pre-clearance period may occur during any vessel activity. If any marine mammal (including delphinids) is observed within or approaching the 100 meter EZ during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the EZ 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).

iv. During ramp-up, PSOs shall monitor the 100-meter EZ and 200-meter buffer zone. Ramp-up may not be initiated if any marine mammal (including delphinids) is observed within or approaching the 100-meter EZ. If a marine mammal is observed within or approaching the 100 meter EZ during ramp-up, a shutdown shall be implemented as though the full array were operational. Ramp-up may not begin again until the animal(s) has been observed exiting the 100-meter EZ or until an additional time period has elapsed with no further sightings (i.e., 15 minutes for small odontocetes and 30 minutes for mysticetes and large odontocetes including sperm, pygmy sperm, and beaked whales).

v. If the air gun array has been shut down for reasons other than mitigation (e.g., mechanical difficulty) for a period of less than 30 minutes, it may be activated again without ramp-up if PSOs have maintained constant visual observation and no visual detections of any marine mammal have occurred within the buffer zone.

vi. Ramp-up at night and at times of poor visibility shall only occur where operational planning cannot reasonably avoid such circumstances. Ramp-up may occur at night and during poor visibility if the 100-meter EZ and 200-meter buffer zone have been continually monitored by visual PSOs for 30 minutes prior to ramp-up with no marine mammal detections.

vii. The vessel operator must notify a designated PSO of the planned start of 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.

e. Shutdown requirements – An exclusion zone of 100 meters shall be established and monitored by PSOs. If a marine mammal is observed within, entering, or approaching the 100 meters exclusion zone all air guns shall be shut down.

  i. Any PSO on duty has the authority to call for shutdown of the air gun array. When there is certainty regarding the need for mitigation action on the basis of visual detection, the relevant PSO(s) must call for such action immediately.

  ii. The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the air gun array to ensure that shutdown commands are conveyed swiftly while allowing PSOs to maintain watch.

  iii. When a shutdown is called for by a PSO, the shutdown must occur and any dispute resolved only following shutdown.

  iv. The shutdown requirement is waived for dolphins of the following genera: *Tursiops*, *Stenella*, *Delphinus, Lagenorhynchus* and *Lissodelphis*. The shutdown waiver only applies if animals are traveling, including approaching the vessel. If animals are stationary and the 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.

  v. Upon implementation of a shutdown, the source may be reactivated under the conditions described at 4(e)(vi). Where there is no relevant zone (e.g., shutdown due to observation of a calf), a 30-minute clearance period must be observed following the last observation of the animal(s).

  vi. Shutdown of the array is required upon observation of a whale (i.e., sperm whale or any baleen whale) with calf, 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, at any distance.

   vii. Shutdown of the array is required upon observation of an aggregation (i.e., six or more animals) of large whales of any species (i.e., sperm whale or any baleen whale) that does not appear to be traveling (e.g., feeding, socializing, etc.) at any distance.

   viii. Shutdown of the array is required upon observation of a killer whale at any distance.

f. Vessel Strike Avoidance – Vessel operator and crew must maintain a vigilant watch for all marine mammals and slow down or stop the vessel or alter course, as appropriate, to avoid striking any marine mammal, unless such action represents a human safety concern. 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 crewmembers, but crewmembers responsible for these duties must be provided sufficient training to distinguish marine mammals from other phenomena.

   i. The vessel must maintain a minimum separation distance of 100 meters from large whales, unless such action represents a human safety concern. The following avoidance measures must be taken if a large whale is within 100 meters of the vessel:

      1. The vessel must reduce speed and shift the engine to neutral, when feasible, 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 unless such action represents a human safety concern.

      2. If the vessel is stationary, the vessel must not engage engines until the whale(s) has moved out of the vessel's path and beyond 100 meters unless such action represents a human safety concern.

   ii. The vessel must maintain a minimum separation distance of 50 meters from all other marine mammals, with an exception made for animals described in 4(e)(iv) that approach the vessel. If an animal is encountered during transit, the vessel shall attempt to remain parallel to the animal's course, avoiding excessive speed or abrupt changes in course unless such action represents a human safety concern.

g. Vessel speeds must be reduced to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near the vessel unless such action represents a human safety concern.

h. Miscellaneous Protocols

  i. The air gun array must be deactivated when not acquiring data (as in during transit) or preparing to acquire data, except as necessary for testing. Unnecessary use of the acoustic source shall be avoided. Operational capacity of 90 in^3 (not including redundant backup air guns) 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. 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:

  i. The operator must 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.

  ii. 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.

j. PSO Qualifications

  i. PSOs must have successfully completed relevant training, including completion of all required coursework and passing 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.

k. 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. The NMFS Permits and Conservation Division requires that, at a minimum, the following information be reported:
   i. PSO names and affiliations
   ii. Dates of departures and returns to port with port name
   iii. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort
   iv. Vessel location (latitude/longitude) when survey effort begins and ends; vessel location at beginning and end of visual PSO duty shifts
   v. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change
   vi. 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
   vii. 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)
   viii. Survey activity information, such as acoustic source power output while in operation, number and volume of air guns 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.)

ix. If a marine mammal is sighted, the following information should be recorded:

1. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
2. PSO who sighted the animal;
3. Time of sighting;
4. Vessel location at time of sighting;
5. Water depth;
6. Direction of vessel's travel (compass direction);
7. Direction of animal's travel relative to the vessel;
8. Pace of the animal;
9. Estimated distance to the animal and its heading relative to vessel at initial sighting;
10. 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;
11. Estimated number of animals (high/low/best);
12. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
13. 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);
14. Detailed behavior observations (e.g., number of blows, number of surfaces, breaching, spy hopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
15. Animal's closest point of approach and/or closest distance from the center point of the acoustic source;
16. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
17. Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up, speed or course alteration, etc.)

and time and location of the action.

l. Reporting

    i. Scripps Institution of Oceanography 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 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 from NMFS on the draft report.

    ii. Reporting injured or dead marine mammals:

    iii. In the event that the specified activity clearly causes the take of a marine mammal in a manner not authorized by this IHA (if issued), such as serious injury or mortality, Scripps Institution of Oceanography shall immediately cease the specified activities and immediately report the incident to NMFS. The report must include the following information:

        1. Time, date, and location (latitude/longitude) of the incident;
        2. Vessel's speed during and leading up to the incident;
        3. Description of the incident;
        4. Status of all sound source use in the 24 hours preceding the incident;
        5. Water depth;
        6. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
        7. Description of all marine mammal observations in the 24 hours

preceding the incident;

8. Species identification or description of the animal(s) involved;
9. Fate of the animal(s); and
10. 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 Scripps Institution of Oceanography to determine what measures are necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. Scripps Institution of Oceanography may not resume their activities until notified by NMFS.

iv. In the event that Scripps Institution of Oceanography 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), Scripps Institution of Oceanography shall immediately report the incident to NMFS. The report must include the same information identified in condition 6(b)(i) of the IHA. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with Scripps Institution of Oceanography to determine whether additional mitigation measures or modifications to the activities are appropriate.

v. In the event that Scripps Institution of Oceanography 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), Scripps Institution of Oceanography shall report the incident to NMFS within 24 hours of the discovery. Scripps Institution of Oceanography shall provide photographs or video footage or other documentation of the sighting to NMFS.

5. 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.

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