

**NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION**

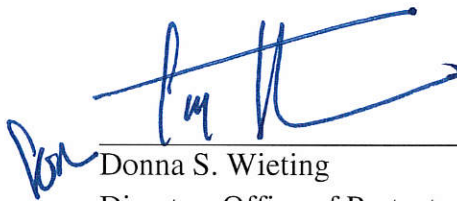
Title: Biological Opinion on the National Science Foundation-funded seismic survey in the North Pacific Ocean, and issuance of an Incidental Harassment Authorization pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act (MMPA)

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division,
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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 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 concur with that determination for species under NMFS jurisdiction, consultation concludes informally (50 C.F.R. §402.14(b)).

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, NMFS provides an opinion stating whether the Federal agency’s action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat. If NMFS determines that the action is likely to jeopardize 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 agency 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’s proposal to fund a seismic survey in the North Pacific Ocean in 2018 and 2019, in support of an NSF-funded collaborative research project, led by Columbia University’s Lamont-Doherty Observatory. The second is the NMFS’ Permits and Conservation Division proposal to issue an incidental harassment authorization (IHA) authorizing non-lethal “takes” by 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 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. §402.

This document represents the NMFS opinion on the effects of these actions on endangered and threatened marine mammals, sea turtles, and fishes and designated and proposed 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 North Pacific Ocean. The survey is composed of two parts: a seismic survey around the Main Hawaiian Islands in late summer 2018, and a seismic survey in the western North Pacific Ocean over the Emperor Seamounts in late spring 2019. In conjunction with this action, the NMFS Permits and Conservation Division would issue an IHA under the MMPA for marine mammal takes that could occur during the NSF seismic survey. This document represents NMFS's ESA Interagency Cooperation Division's opinion on the effects of the two proposed federal actions on threatened and endangered species, and has been prepared in accordance with section 7 of the ESA.

1.2 Consultation History

On March 15, 2018, 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 March 16, 2018, the NMFS' Permits and Conservation Division received an application from the Lamont-Doherty Earth Observatory of Columbia University to incidentally harass marine mammal species pursuant to the MMPA during the proposed seismic survey.

The Permits and Conservation Division and the ESA Interagency Cooperation Division had several questions on the IHA request and draft environmental analysis regarding sources of marine mammal density information, and requested additional explanations. As a result, the NSF submitted revised versions of the IHA request and draft environmental analysis, on April 30, 2018. Information was sufficient to initiate consultation with the NSF on this date.

On July 6, 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. Information was sufficient to initiate consultation with the Permits and Conservation Division on this date.

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 action area with the spatial extent of those stressors.

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. This is our exposure analysis. We evaluate the available evidence to determine how individuals of those ESA-listed species are likely to respond given their probable exposure. We also consider how the action may affect designated critical habitat. This is our response analysis. We assess the consequences of these responses of individuals that are likely to be exposed to the populations those individuals represent, and the species those populations comprise. This is our risk analysis. The adverse modification analysis considers the impacts of the proposed action on the essential biological features and conservation value of designated critical habitat.

Integration and Synthesis (Section 12): we integrate the analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS’ jurisdiction.

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. 50 C.F.R. §402.14(j). Finally, we identify the circumstances in which reinitiation of consultation is required. 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 (R/V) *Langseth*, operated by the Lamont Doherty Earth Observatory of Columbia University, to conduct two seismic surveys in the North Pacific Ocean in 2018 and 2019. The

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

3.1 Proposed Activities: National Science Foundation

The NSF proposes to fund the use of the R/V *Langseth*, operated by the Lamont Doherty Earth Observatory of Columbia University, to conduct two seismic surveys in the North Pacific Ocean. An array of 36 operational air guns will be deployed as an energy source, with a 15-kilometer (km) hydrophone streamer and ocean bottom seismometers as the receiving system. In addition, a multibeam echosounder and sub-bottom profiler will continuously operate from the R/V *Langseth* during the entire cruise, but not during transit to and from the survey areas.

The NSF's proposed action will involve two seismic surveys in the North Pacific Ocean—one around the Main Hawaiian Islands, and the other over the Emperor Seamounts in the western North Pacific Ocean. The research goals of the surveys would be to gain a better understanding of the formation and evolution of the Hawaiian-Emperor Seamount chain, and providing valuable information regarding geohazards like tsunamis, submarine landslides, and earthquakes.

3.1.1 Main Hawaiian Islands: Survey Overview and Schedule

The survey around the Main Hawaiian Islands would consist of four survey tracklines; two lines running roughly north to south (Lines 1 and 2), and two running east to west (Lines 3 and 4). There would be a fifth optional line running east to west, which would be surveyed in place of another east to west survey trackline, if necessary. Lines 1 and 2 would be surveyed twice, once for seismic refraction data, and once for multi-channel seismic reflection profiling. Lines 3 and 4 would only be surveyed once for multi-channel seismic reflection profiling data. The *Langseth* would depart and return to port in Honolulu.

The Main Hawaiian Islands survey would take place in waters 700 to 5,000-meters (m) deep. Most (98.5 percent) of the 3,455-km surveyed would be in waters greater than 1,000-m deep.

The Main Hawaiian Islands survey would last for 36 days. This would include 19 days of seismic activities, 11 days of equipment retrieval, 3 days of operational contingency, and 3 days of transit. The survey would take place in early September 2018, and would conclude in early to mid-October.

3.1.2 Emperor Seamounts: Survey Overview and Schedule

In the Emperor Seamounts survey, there would be three tracklines. Data on two lines with ocean bottom seismometers would be acquired twice, for refraction then reflection data. The third line would be surveyed once for multi-channel seismic reflection data. The *Langseth* would depart from port in Honolulu, Hawaii, and return to port in Alaska at the conclusion of the Emperor Seamounts survey (either Adak or Dutch Harbor, Alaska).

All 2,202-km of seismic transect lines would take place in deep water, between 1,500 and 6,000-m in depth.

The Emperor Seamounts survey would take 42 days total. The seismic operations would last for 13 days. Equipment deployment and retrieval would take 11 days. The survey would have 5.5 days of operational contingency, and 12.5 days of transit. The sail dates for the Emperor Seamounts survey are not determined yet, but it would likely take place in late spring or early summer of 2019.

3.1.3 Source Vessel Specifications

The seismic survey will involve one source vessel, the U.S.-flagged R/V *Langseth*. The R/V *Langseth* is owned by the National Science Foundation and operated by Columbia University's Lamont-Doherty Earth Observatory. The R/V *Langseth* will tow a source airgun array as a sound source along predetermined lines. The R/V *Langseth* has a length of 72-m (235-feet [ft]), a beam of 17-m (56-ft), and a maximum draft of 5.9-m (19.4 ft). Its propulsion system consists of two diesel Bergen BRG-6 engines, each producing 3,550 horsepower, and an 800 horsepower bowthruster. The R/V *Langseth*'s design is that of a seismic research vessel, with a particularly quiet propulsion system to avoid interference with the seismic signals. The operating speed during seismic data acquisition is typically approximately 4.1 knots. When not towing seismic survey gear, the R/V *Langseth* typically cruises at 18.5-km per hour (10 knots) and has a range of approximately 13,500-km (7,289.4-nmi). No chase vessel will be used during seismic survey activities. The R/V *Langseth* will also serve as the platform from which vessel-based protected species observers (acoustic and visual) will listen and watch for animals (e.g., marine mammals and sea turtles).

3.1.4 Air Gun Description

The air gun configuration includes four strings with 36 air guns (with four spares), with its source output directed downward (Table 1). The air gun configuration includes four of linear arrays or "strings". Each string will have ten air guns. Up to nine air guns in one string would fire at any one time. The air guns will be towed at a depth of 12-m, and fire every 50-m for the multichannel seismic lines, and every 150-m for the lines with the ocean bottom seismometers. A 15-km 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	36 inline 45-in ³ air guns
Source output (downward)-36 air gun array	Zero to peak = 230.9 dB re 1 μ Pa-m Peak to peak = 236.7 dB re 1 μ Pa-m
Air discharge volume	~ 6,600-in ³
Dominant frequency components	0 to 188 hertz
Tow depth	12-meters

3.1.5 Ocean Bottom Seismometer Deployment

Seismic survey lines for the Main Hawaiian Islands and Emperor Seamounts surveys have been designated for the collection of refraction data. These lines would have ocean bottom seismometers placed on the ocean floor before beginning that survey line. The number and type of ocean bottom seismometer used would vary by survey. All ocean bottom seismometers have the same retrieval system. To retrieve an ocean bottom seismometer, an acoustic release transponder activates the instrument at a frequency of 8 to 11 kHz, and the receiver detects the response at a frequency of 11.5 to 13 kHz, at which point the burn-wire releases the instrument from the anchor and the device floats to the surface.

3.1.5.1 Main Hawaiian Islands Survey

For the Main Hawaiian Islands seismic survey, 70 ocean bottom seismometers would be used. The ocean bottom seismometers would be placed along Lines 1 and 2, with 35 ocean bottom seismometers on each line, about 15-km apart. The ocean bottom seismometers would come from two sources within the Ocean Bottom Seismograph Instrument Pool—the Woods Hole Oceanographic Institution and the Scripps Institution of Oceanography (Table 2).

Table 2. Specifications for the ocean bottom seismometers to be used in the proposed action.

Institution	Woods Hole Oceanographic Institution	Scripps Institution of Oceanography	Geomar Helmholtz Centre for Ocean Research Kiel
Name	D2	L-Cheapo	Long-term OBS for Tsunami and Earthquake Research
Dimensions	1-m high, 50-cm diameter	1-m high, 1-m diameter	165 by 130 by 72-cm

Institution	Woods Hole Oceanographic Institution	Scripps Institution of Oceanography	Geomar Helmholtz Centre for Ocean Research Kiel
Anchor Type	Hot-rolled Steel	Iron Grates	Titanium Frame/Steel
Anchor Dimensions	23-kilograms 2.5 by 30.5 by 38.1-cm	36-kilograms 7 by 91 by 91.5-cm	335-kilograms

3.1.5.2 Emperor Seamount Survey

The Emperor Seamount survey will use 32 ocean bottom seismometers. Seven will come from either the Woods Hole Oceanographic Institution or the Scripps Institution of Oceanography (see Table 2). The remaining 25 ocean bottom seismometers will be provided by the Geomar Helmholtz Centre for Ocean Research Kiel. The 32 ocean bottom seismometers would be deployed twice, once along the east to west survey line, then retrieved and re-deployed along the north to south survey line.

3.1.6 Multibeam Echosounder, Sub-bottom Profiler, and Acoustic Doppler Current Profiler

Along with air gun operations, additional acoustical data acquisition systems will operate during the surveys from the *Langseth*. 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 *Langseth* 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 dB re 1 $\mu\text{Pa}\cdot\text{m}$ (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 $\mu\text{Pa}\cdot\text{m}_{\text{rms}}$ (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°.

During operations, the *Langseth* will also use a Teledyne RDI 75 kHz Ocean Surveyor acoustic Doppler current profiler to measure water current velocities. The acoustic Doppler current

profiler will operate at a frequency of 75 kHz and a maximum sound source level of 224 dB re: 1 μ Pa m (rms) over a conically shaped 30° beam.

3.1.7 Mitigation and Monitoring

Mitigation is a measure that avoids or reduces the severity of the effects of the action on ESA-listed species. The National Science Foundation and Lamont-Doherty Earth Observatory are obligated to enact measures to have their action result in the least practicable adverse impact on marine mammal species or stocks and to reduce the likelihood of adverse effects to ESA-listed marine species or adverse effects to their designated critical habitats. Monitoring is used to observe or check the progress of the mitigation over time and to ensure that any measures implemented to reduce or avoid adverse effects on ESA-listed species are successful.

NMFS Permits and Conservation Division will require and the National Science Foundation and Lamont-Doherty Earth Observatory will implement the mitigation and monitoring measures listed below. These mitigation and monitoring measures are required during the seismic surveys to reduce potential for injury or harassment to marine mammals and sea turtles. Additional detail for each mitigation and monitoring measure is described in subsequent sections of this opinion:

- Proposed exclusion and buffer zones;
- Power-down procedures;
- Shut-down procedures;
- Ramp-up procedures;
- Visual monitoring;
- Passive acoustic monitoring;
- Ship strike avoidance measures; and
- Additional mitigation measures considered.

We discuss the proposed exclusion and buffer zones in more detail in the next section. Details for the other mitigation and monitoring measures (e.g., power-down, shut-down, and ramp-up procedures, etc.) can be found in Appendix A.

3.1.7.1 Proposed Exclusion and Buffer Zones

The NSF identifies in its draft Environmental Assessment that the Lamont-Doherty Earth Observatory will implement exclusion zones around the *Langseth* 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 *Langseth*, 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 thirty-six 45-in³ Generator-Injector (GI) air guns in intermediate and deep water. In 2003, empirical data concerning 190, 180, and 160 dB re 1

$\mu\text{Pa}_{\text{rms}}$ 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 *Langseth* (Diebold 2010; Tolstoy et al. 2009). As a 36-airgun 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-m) from in the proposed survey (12-m). Because propagation varies with array depth, correction factors have been applied to the distances reported by Tolstoy et al. (2009).

The NMFS Permits and Conservation Division will require, and the National Science Foundation and Lamont-Doherty Earth Observatory will implement exclusion zones around the *Langseth* to minimize any potential adverse effects of the sound from the airgun array on MMPA and ESA-listed species. The exclusion zones are areas within which occurrence of a marine mammal triggers a power-down or shut-down of the airgun array, to reduce exposure of marine mammals and sea turtles to sound levels expected to have adverse effects on the species or habitats. These exclusion zones are based upon modeled sound levels at various distances from the *Langseth*, and correspond to the respective species sound threshold for ESA harm (e.g., injury) and harassment.

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 3 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 $\mu\text{Pa}_{\text{rms}}$ 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).

In their incidental harassment authorization application, Lamont-Doherty Earth Observatory proposed to establish exclusion zones based upon modeled radial distances to auditory injury zones. However, the NMFS Permits and Conservation Division instead proposed the 500-m

exclusion zone. Potential radial distances to auditory injury zones were calculated on the basis of maximum peak pressure using values provided by the Lamont-Doherty Earth Observatory. The 500-m (1,640.4-ft) radial distance of the standard exclusion zone is intended to be precautionary in the sense that it will be expected to contain sound exceeding peak pressure injury criteria for all cetacean hearing groups, while also providing a consistent, reasonably observable zone within which protected species observers will typically be able to conduct effective observational effort. Although significantly greater distances may be observed from an elevated platform, NMFS believes that 500-m is a reasonable visual monitoring zone for protected species observers to observe marine mammals using the naked eye during typical conditions.

A practicable criterion such as this has the advantage of simplicity while still providing in most cases an exclusion zone larger than relevant auditory injury zones, given realistic movement of the airgun array and receiver, and sufficient to reduce or avoid most adverse impacts from exposure to the sound source.

An exclusion zone is a defined area within which occurrence of a marine mammal triggers mitigation action intended to reduce the potential for certain outcomes (e.g., auditory injury, disruption of critical behaviors). Protected species observers will establish a default (minimum) exclusion zone with a 500-m radius for visual monitoring for the 36 airgun arrays. The 500-m exclusion zone will be based on the radial distance from any element of the airgun array (rather than being based on the center of the airgun array or around the vessel itself). With certain exceptions (described in the IHA), if a marine mammal appears within, enters, or appears on course to enter this zone, the airgun array will be powered-down or shut-down, depending on the circumstance. In addition to the 500-m exclusion zone for the 36 airgun array, a 100-m (328.1-ft) exclusion zone will be established for the single 40-in³ airgun. A power-down occurs when a marine mammal is detected outside the exclusion zone and appears likely to enter (or is already within the exclusion zone when first detected), and the airgun array is reduced from 36 airguns to a single airgun. A shut-down occurs when a marine mammal is detected outside the exclusion zone and appears likely to enter (or is already within the exclusion zone when first detected), and the single airgun array is turned off entirely. Additionally, a power-down of the 36 airgun arrays will last no more than 30 minutes maximum at any given time; thus, the airgun array will be shut-down entirely if, after 30 minutes of power-down, a marine mammal remains inside the 500-m exclusion zone.

The protected species observers will also establish and monitor a 1,000-m (3,280.8-ft) buffer zone. During use of the airgun arrays, occurrence of marine mammals within the buffer zone (but outside the 500-m exclusion zone) will be communicated to the operator to prepare for the potential power-down or shut-down of the airgun array. The protected species observers will monitor the entire extent of the modeled MMPA Level B harassment zone (or, as far as they are able to see, if they cannot see to the extent of the estimated MMPA Level B harassment zone). The protected species observers will also establish and monitor a buffer zone and exclusion zone for sea turtles. An exclusion zone of 100-m would be used as a shut-down distance for sea

turtles. The buffer zone will correspond to the predicted 175 dB re: 1 μ Pa (rms) threshold distances and the exclusion zone will correspond to the predicted 195 dB re: 1 μ Pa (rms) threshold distances to which sound source levels will be received from the single airgun array and 36 airgun array in intermediate and deep water depths described in Table 3.

Table 3. Predicted distances to which sound levels ≥ 160 , 175, and 195 dB re 1 μ Pa could be received from the single and 36-airgun array towed at 12-meters.

Air gun Configuration	Water Depth (meters)	Predicted rms radii (meters)		
		160 dB	175 dB	195 dB
Single bolt airgun (40-in ³)	>1,000-m	431	77	8
	100-1,000-m	647	116	11
36 airguns (6,600-in ³)	>1,000-m	6,733	1,864	181
	100-1,000-m	10,100	2,796	272

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" 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, fin whales, sei whales, sperm whales, Western North Pacific distinct population segment (DPS) humpback whales, gray whales, Main Hawaiian Islands Insular false killer whales, North Pacific right whales, and Hawaiian monk seals. The IHA will also authorize incidental take for other marine mammals listed under the MMPA. The proposed IHA identifies requirements that the NSF and Lamont-Doherty Earth Observatory 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 two locations in the Pacific Ocean. The first seismic survey will take place around the Main Hawaiian Islands (Figure 1). The second seismic survey would take place over the Emperor Seamounts in the North Pacific Ocean, within approximately 43 to 48° North, and 166 to 173° East (Figure 2). The action area would also include the area covered by the *Langseth* while transiting to and from its port in Honolulu to the survey area around the Main Hawaiian Islands, and from Honolulu to the survey area over the Emperor Seamounts, and its return to port in Alaska at the conclusion of the survey.

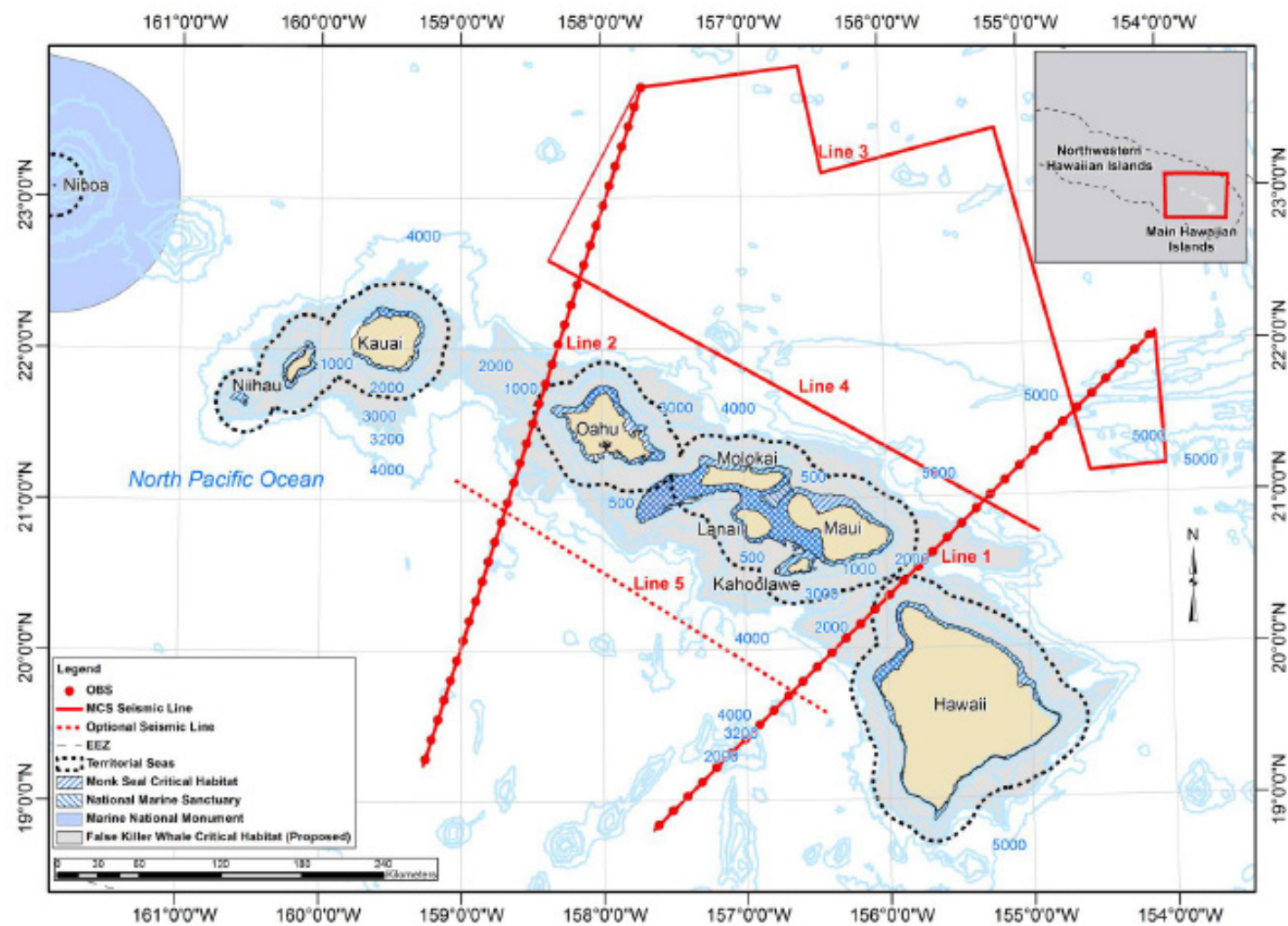


Figure 1. Map of the Main Hawaiian Islands action area.

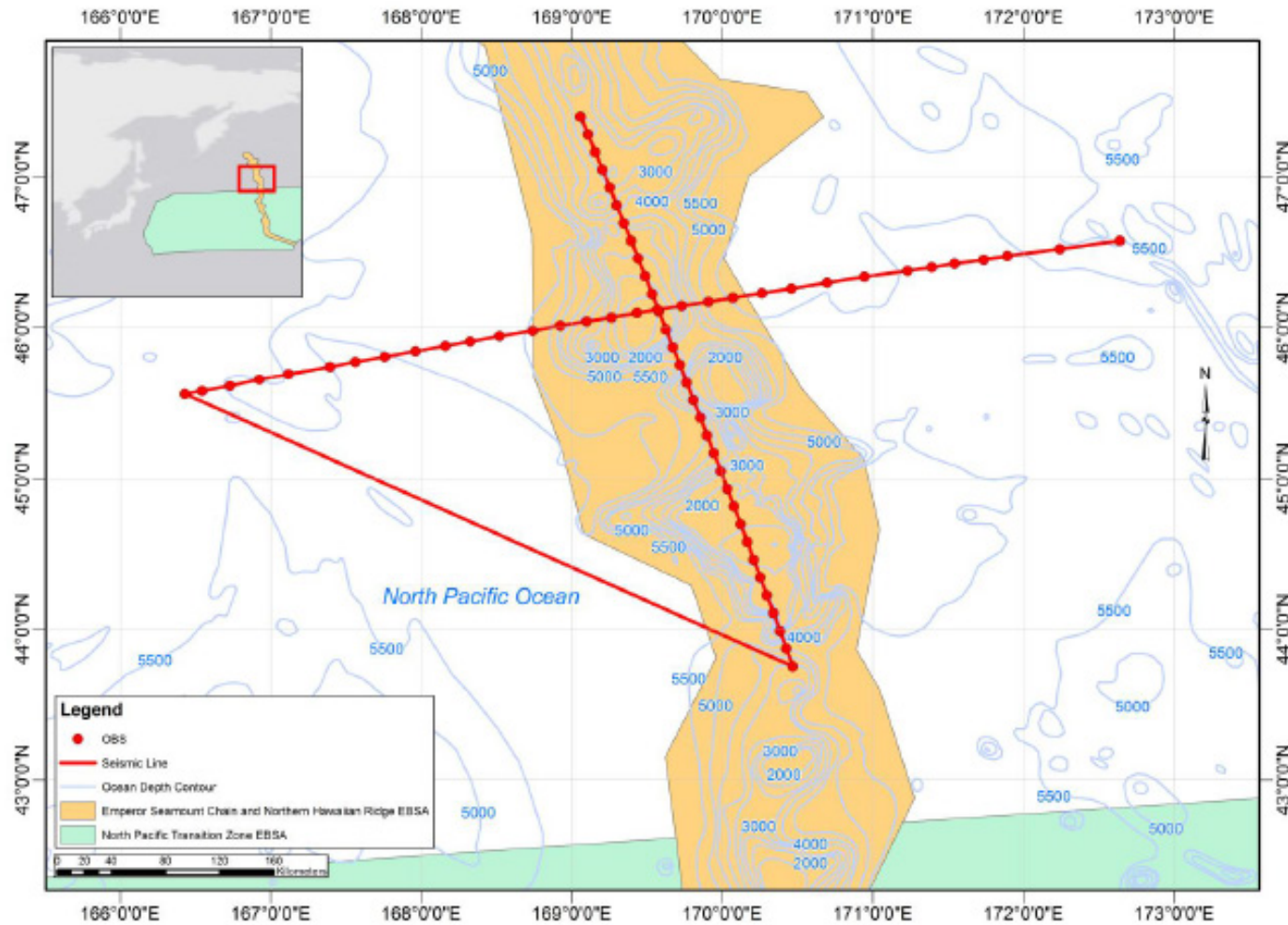


Figure 2. Map of the Emperor Seamounts action area.

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 10.3.

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 4, 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 4.

Table 4. 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 (<i>Balaenoptera musculus</i>)	E – 35 FR 18319	-- --	07/1998
Fin Whale (<i>Balaenoptera physalus</i>)	E – 35 FR 18319	-- --	75 FR 47538
Sei Whale (<i>Balaenoptera borealis</i>)	E – 35 FR 18319	-- --	76 FR 43985
Sperm Whale (<i>Physeter macrocephalus</i>)	E – 35 FR 18319	-- --	75 FR 81584

Species	ESA Status	Critical Habitat	Recovery Plan
False Killer Whale (<i>Pseudorca crassidens</i>) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	83 FR 35062	-- --
Gray Whale (<i>Eschrichtius robustus</i>) Western North Pacific Population	E – 35 FR 18319	-- --	-- --
North Pacific Right Whale (<i>Eubalaena japonica</i>)	E – 73 FR 12024	73 FR 19000	78 FR 34347 06/2013
Humpback Whale (<i>Megaptera novaeangliae</i>) – Western North Pacific DPS	E – 81 FR 62259	-- --	11/1991
Humpback Whale (<i>Megaptera novaeangliae</i>) – Mexico DPS	T – 81 FR 62259	-- --	11/1991
Sea Turtles			
Loggerhead Turtle (<i>Caretta caretta</i>) – North Pacific Ocean DPS	E – 76 FR 58868	-- --	63 FR 28359
Leatherback turtle (<i>Dermochelys coriacea</i>)	E – 35 FR 8491	77 FR 4170	05/1998 – U.S. Pacific
Olive Ridley Turtle (<i>Lepidochelys olivacea</i>) Mexico's Pacific Coast Breeding Colonies	E – 43 FR 32800	-- --	63 FR 28359
Green Turtle (<i>Chelonia mydas</i>) – Central North Pacific DPS	T – 81 FR 20057	-- --	63 FR 28359
Hawksbill Turtle (<i>Eretmochelys imbricata</i>)	E – 35 FR 8491	63 FR 46693	05/1998 – U.S. Pacific
Fishes			
Giant Manta Ray (<i>Manta birostris</i>)	T – 83 FR 2916	-- --	-- --
Green Sturgeon (<i>Acipenser medirostris</i>) – Southern DPS	T – 71 FR 17757	74 FR 52300	2010 (Outline)
Oceanic Whitetip Shark (<i>Carcharhinus longimanus</i>)	T – 83 FR 4153	-- --	-- --
Sakhalin Sturgeon (<i>Acipenser mikadoi</i>)	E – 79 FR 31222	-- --	-- --
Scalloped Hammerhead Shark (<i>Sphyrna lewini</i>) – Indo-West Pacific DPS	T – 79 FR 38213	-- --	-- --
Marine Mammals – Pinnipeds			
Hawaiian Monk Seal (<i>Neomonachus schauinslandi</i>)	E – 41 FR 51611	80 FR 50925	72 FR 46966 2007

Species	ESA Status	Critical Habitat	Recovery Plan
Steller Sea Lion (<i>Eumetopias jubatus</i>) – Western DPS	E – 55 FR 49204	58 FR 45269	73 FR 11872 2008

7.1 Species Not Likely to be Adversely Affected

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

The second criterion is the probability of a response given exposure. 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 species ESA-listed 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 Western Distinct Population Segment Steller Sea Lion and Critical Habitat

The Western DPS of Steller sea lion is listed as endangered throughout its range, extending from the 144° West longitude, through the Gulf of Alaska, Aleutian Islands, and into the Bering Sea. Generally, Steller sea lion stocks towards the eastern end of the range (the Eastern, Central, and Western Gulf of Alaska) are experiencing positive population trends, while populations in the west are experiencing negative trends. Both pup and non-pup Steller sea lions in the Central

Aleutian region are experiencing decreasing trends (Muto 2016). Adak, one possible location where the *Langseth* will return to port, is in the Central Aleutian region. Steller sea lions forage near shore and pelagic waters on a wide variety of fishes, including capelin, cod, herring, mackerel, etc. Their movements are thought to be driven by prey availability. A study examining the movements of pups and juveniles (12 to 35 months) in the Gulf of Alaska showed that most (90 percent) of juveniles typically did not venture far from their natal rookery, staying within 15-km of it (Raum-Suryan et al. 2004). Adults move farther, usually staying within 500-km of their natal rookery (Raum-Suryan et al. 2002). Adult males are also capable of traveling long distances in a season (over 1,000-km) (NMFS 2013d). Their distribution is mainly along coasts to the outer continental shelf, and they can dive to approximately 1,300 ft (400-m) in depth (NMFS 2013d). The Emperor Seamounts are roughly 1,200-km away from the Aleutian Islands in waters 2,000 to more than 5,000-m deep. Since the seismic activities will occur in a location where we do not expect Steller sea lions to be, we believe that it is extremely unlikely that Steller sea lions would be exposed to the stressors associated with the proposed seismic activities. We determine that Steller sea lions of the Western DPS are not likely to be adversely affected by the proposed action.

Steller sea lions may also be exposed to the stressors associated with vessel activity while the *Langseth* is returning to port. These stressors could include vessel strike, pollution by oil or fuel leakage, and acoustic interference from engine noise. 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 *Langseth* 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. We are not aware of a ship-strike by a seismic survey vessel. The *Langseth* 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 ship strike is discountably small due to the hundreds of thousands of kilometers the *Langseth* has traveled without a ship strike, general expected movement of marine mammals away or parallel to the *Langseth*, as well as the generally slow movement of the *Langseth* during most of its travels (Hauser and Holst 2009; Holst 2009; Holst 2010; Holst and Smultea 2008a). Because the potential for ship strike or a fuel leak is extremely unlikely to occur, we find that the risk from these potential stressors is discountable. We expect that the *Langseth* 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. 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. We conclude that the stressors associated with vessel activity are not likely to adversely affect Western DPS Steller sea lions.

Steller sea lion critical habitat has been designated in Alaska around all major haul-outs and rookeries, including on the Unalaska Island (nearing Dutch Harbor) and Adak Island, both potential return ports for the *Langseth*. The critical habitat designation consists of a 20 nautical mile buffer around haul-outs and rookeries, and includes terrestrial, air, and aquatic areas that support reproduction, foraging, rest, and refuge. The *Langseth* would be passing through designated critical habitat while returning to port in Alaska. There could be some minor disturbances caused by the vessel's presence, but we expect that those would be temporary, and not affect the conservation value of the physical and biological features or overall suitability of the critical habitat. We conclude that the affects to Steller sea lion designated critical habitat from the proposed action would be insignificant, and that it would not be adversely affected. It will not be considered further.

7.1.2 Hawaiian Monk Seal Critical Habitat

Critical habitat for Hawaiian monk seal has been designated in the proposed action area in the Main Hawaiian Islands. The designation includes terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing, marine areas from 0 to 200-m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging, and significant areas used by monk seals for hauling out, resting, or molting.

The seismic survey lines around the Main Hawaiian Islands are outside the 200-m isobaths, putting them outside the critical habitat. For the most part, Hawaiian monk seals in the Main Hawaiian Islands conduct foraging dives to depths of 200-m or less, only rarely diving deeper (Cahoon 2011). The survey would take place in waters 700-m and deeper. The Permits and Conservation Division conducted a spatial analysis, looking at the extent of the ensonified area of the Hawaii survey lines and its proximity to Hawaiian monk seal critical habitat. In waters of intermediate depth (100 to 1,000-m), the ensonified area is 10.1-km, larger than it is in deep water (greater than 1,000-m). There are two portions of Lines 1 and 2 where the 10.1-km ensonified area borders the Hawaiian monk seal critical habitat, near the islands of Oahu and Hawaii (Figure 3).

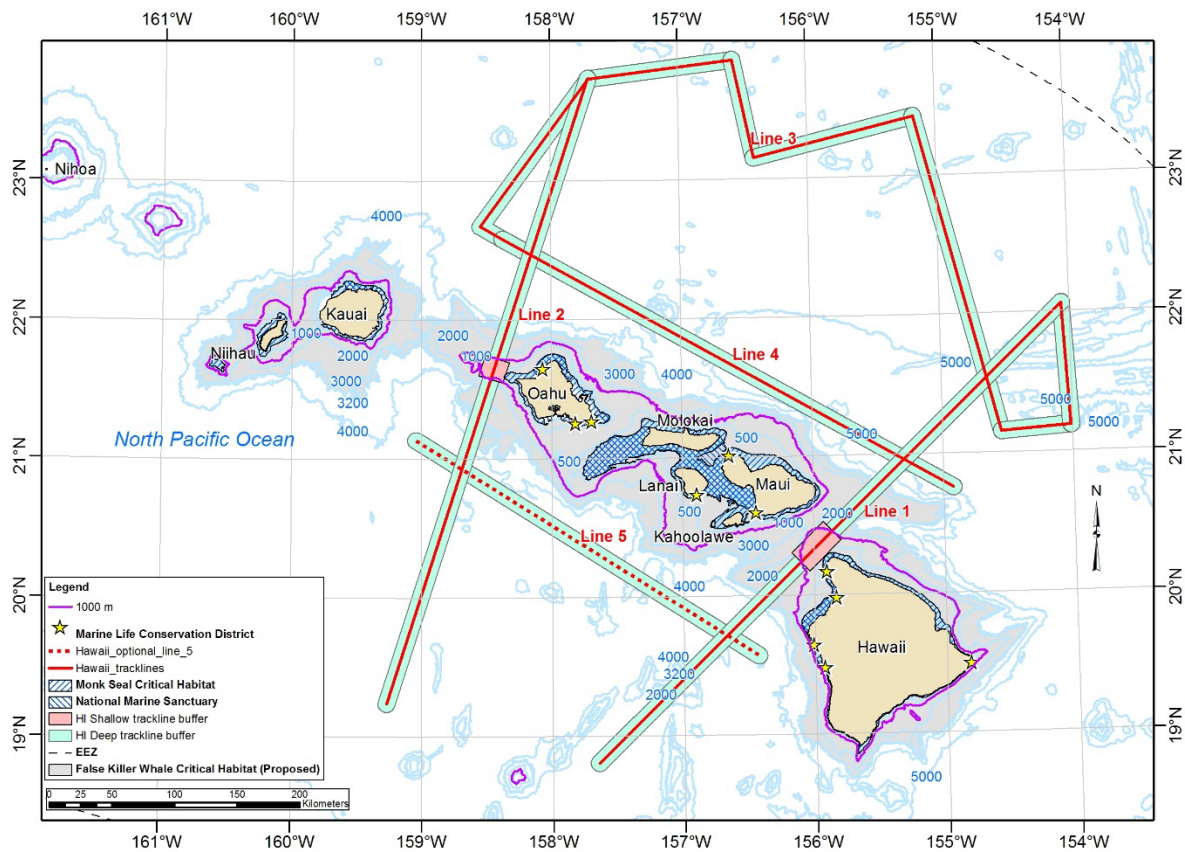


Figure 3. Map showing extent of ensonified areas around proposed seismic survey lines in the Main Hawaiian Islands. From the Permits and Conservation Division.

Since the proposed action will take place in the marine environment, we do not expect the terrestrial or shallow, sheltered habitats of the designated critical habitat to be affected. However, the physical and biological feature concerning foraging habitat and adequate prey quality and quantity for juvenile and adult Hawaiian monk seals warrants further examination.

The 10.1-km exclusion zone is based on the 160 dB received sound level for marine mammals, and represents the area where we would expect marine mammals to experience harassment from the seismic activity in intermediate depth waters. Fish, however, exhibit responses from noise and seismic surveys at different sound levels, and thus, the predicted distances to received sound levels for fishes would be different than for other taxon (perhaps experiencing effects at greater distances). As such, we cannot assume that because the 10.1-km exclusion zone is outside the Hawaiian monk seal critical habitat, that prey species such as fish inside the critical habitat would not be affected. The sound from the seismic survey may extend into the designated critical habitat and impact fish prey species there, albeit at a different level than that we would expect marine mammals to be affected.

In the Main Hawaiian Islands, monk seal's diet is composed mostly of fishes from the families Balistidae (triggerfishes), Acanthuridae (surgeonfishes, tangs, and unicornfishes), Muraenidae (moray eels), Serranidae (grouper), and others (Cahoon 2011). In one study, cephalopod prey composed 18.3 percent on Hawaiian monk seals' diet, mostly species of octopi, and some squid. Crustacean remains were found, but their contribution to the monk seals' diet is unknown (Cahoon 2011).

In its draft Environmental Assessment, the NSF discussed the effects of the proposed seismic activities on marine fishes and invertebrates, including a discussion on the sub-lethal effects of seismic activities on Hawaiian monk seal prey species such as cephalopods and squid. Based on the information presented in the draft Environmental Assessment, there is no specific evidence that these particular fish prey for Hawaiian monk seals would be adversely affected by the proposed action. In general, we expect that fish species would be disturbed or displaced temporarily by the proposed seismic activities; see discussion in the Response Analysis (Section 10.3.5.1) for more details. Solé et al. (2013) found that cephalopod species exposed to frequencies between 315 and 400 Hz and levels between 139 to 141 re 1 microPa² experienced loss of muscle tone, stressed behavior, startle behavior, and damage to the statocyst, the organ responsible for equilibrium and movement. Squid (*Sepioteuthis australis*) exhibited stressed behavior and changed swimming patterns at sound exposure levels of greater than 147 to 151 dB re 1 microPa² · s (Fewtrell and McCauley 2012). Assuming that fish and squid prey species present in the action area react the same as did the species in these studies, we expect that Hawaiian monk seal prey would exhibit similar responses.

The total amount of time the seismic survey would occur in or near (about 10-km) Hawaiian monk seal critical habitat is brief, and would amount to less than a day. The short duration of the potential exposure, and the expected minor effects to prey species, lead us to conclude that the Hawaiian monk seal critical habitat would not be adversely affected by the proposed action. We expect that the effects to the prey species would be insignificant, and would not affect the conservation value of the critical habitat. It will not be considered further in this opinion.

7.1.3 Elasmobranchs—Oceanic Whitetip Shark and Giant Manta Ray

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

Elasmobranchs, like all fish, have an inner ear capable of detecting sound and a lateral line capable of detecting water motion caused by sound (Hastings and Popper 2005; Popper and Schilt 2009). Data for elasmobranch fishes suggest they are capable of detecting sounds from approximately 20 Hz to 1 kHz with the highest sensitivity to sounds at lower ranges (Casper et al. 2012; Casper et al. 2003; Casper and Mann 2006; Casper and Mann 2009; Ladich and Fay

2013; Myrberg 2001). However, unlike most teleost fish, elasmobranchs do not have swim bladders (or any other air-filled cavity), and thus are unable to detect sound pressure (Casper et al. 2012). Particle motion is presumably the only sound stimulus that can be detected by elasmobranchs (Casper et al. 2012). Given their assumed hearing range, elasmobranchs are anticipated to be able to detect the low frequency sound from an airgun array if exposed. However, the duration and intensity of low-frequency acoustic stressors and the implementation of conservation measures (described in 3.1) 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 μ Pa at an onset rate of 96 dB re: 1 μ Pa per second to a peak amplitude of 123 dB re: 1 μ Pa received level from a continuous level, just masking broadband ambient sound (Klimley and Myrberg 1979). In the same study, lemon sharks withdrew from artificial sounds that included 10 pulses per second and 15 to 7.5 decreasing pulses per second.

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

These signals, some “pulsed,” are not substantially different from the airgun array signals. Myrberg et al. (1978) reported that silky shark withdrew 10 m from a speaker broadcasting a 150 to 600 Hz sound with a sudden onset and peak source level of 154 dB re: 1 μ Pa. These sharks avoided a pulsed low frequency attractive sound when its sound level was abruptly increased by more than 20 dB re: 1 μ Pa. 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 ocellatum*) sharks, and wild great white sharks (*Carcharodon carcharius*). The strobe lights alone (and the lights with sound) reduced the number of times bait was taken by Port Jackson and epaulette sharks. The strobe lights alone did not change white shark behavior, but the sound and the strobe light together led to great white sharks spending less time near bait. Sound alone did not have an effect on great white shark behavior (Ryan et al. 2017). The sound sources used in this study are different than the airguns used in the proposed action, but are still somewhat similar as they are both fairly low frequency sounds.

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

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

7.1.4 Southern Distinct Population Segment Green Sturgeon

Green sturgeon have been reported in the Bering Sea and the western Gulf of Alaska (Colway and Stevenson 2007). These are rare occurrences, and it is unknown which DPS these individuals belonged to (i.e., the Southern or the non-listed Northern DPS) (Doukakis 2014). Adult green sturgeon of the Northern DPS move into rivers in late winter to early summer to spawn. In the marine environment, sub-adult and adult green sturgeon typically occupy depths between 20 and 70 m deep; both DPSs prefer waters less than 100 m deep (NMFS 2015b). There is no evidence to suggest that green sturgeon would be near the Emperor Seamounts, and thus they are not likely to be exposed to the seismic activities. The reports of green sturgeon in the Bering Sea are likely rare and extra-limital; only three have ever been reported. The *Langseth* would return to

port in Adak, Alaska, part of the Aleutian Islands bordering the Bering Sea. At most, green sturgeon may be exposed to the stressors associated with vessel activity, and even still, we could not say with any certainty that the exposed individual would belong to the ESA-listed Southern DPS. We consider the exposure of Southern DPS green sturgeon to the stressors associated with vessel activity to be extremely unlikely to occur, and to be discountable. We conclude that Southern DPS green sturgeon are not likely to be adversely affected by the proposed action and will not be considered further.

7.1.5 Designated Critical Habitat not in the Action Area

Critical habitat has been designated for the following species, but these areas are outside the proposed action area: Southern DPS green sturgeon, North Pacific right whale, and leatherback sea turtle. The proposed action will take place in the waters surrounding the Main Hawaiian Islands, the Emperor Seamounts, and waters of the North Pacific Ocean used to transit from Honolulu, Hawaii, to Adak or Dutch Harbor, Alaska. The critical habitat designations for green sturgeon and leatherback sea turtle are on the West Coast of the United States, well outside of the proposed action area. Designated critical habitat for the North Pacific right whale is in the Bering Sea, north of either of the potential ports the *Langseth* will return to at the conclusion of the survey. Since the critical habitat for these species does not occur in the proposed action area, there will be no effect, and these critical habitat designations will not be considered further.

8 SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

This section identifies the ESA-listed species that occur within the action area (Figure 1 and Figure 2) that may be adversely affected by the proposed seismic activities and IHA issuance. All of the species potentially occurring within the action area are ESA-listed in Table 5, along with their regulatory status.

Table 5. Threatened and endangered species that may be adversely affected by NSF's proposed action of seismic activities in the North Pacific Ocean, and the Permits and Conservation Division's proposed issuance of an Incidental Harassment Authorization.

Species	ESA Status	Critical Habitat
Blue Whale (<i>Balaenoptera musculus</i>)	E – 35 FR 18319	-- --
Fin Whale (<i>Balaenoptera physalus</i>)	E – 35 FR 18319	-- --
Sei Whale (<i>Balaenoptera borealis</i>)	E – 35 FR 18319	-- --
Sperm Whale (<i>Physeter macrocephalus</i>)	E – 35 FR 18319	-- --
False Killer Whale (<i>Pseudorca crassidens</i>) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	83 FR 35062

Species	ESA Status	Critical Habitat
Gray Whale (<i>Eschrichtius robustus</i>) Western North Pacific Population	E – 35 FR 18319	-- --
North Pacific Right Whale (<i>Eubalaena japonica</i>)	E – 73 FR 12024	N/A*
Humpback Whale (<i>Megaptera novaeangliae</i>) – Western North Pacific DPS	E – 81 FR 62259	-- --
Hawaiian Monk Seal (<i>Neomonachus schauinslandi</i>)	E – 41 FR 51611	N/A*
Loggerhead Turtle (<i>Caretta caretta</i>) – North Pacific Ocean DPS	E – 76 FR 58868	-- --
Leatherback turtle (<i>Dermochelys coriacea</i>)	E – 35 FR 8491	N/A*
Olive Ridley Turtle (<i>Lepidochelys olivacea</i>) Mexico's Pacific Coast Breeding Colonies	E – 43 FR 32800	-- --
Green Turtle (<i>Chelonia mydas</i>) – Central North Pacific DPS	T – 81 FR 20057	-- --
Hawksbill Turtle (<i>Eretmochelys imbricata</i>)	E – 35 FR 8491	-- --

*Critical habitat has been designated for these species, but we have determined that it will not be affected by the proposed action, either because it is not within the action area, or it will not be adversely affected by the proposed action. See Section 7.1 for more details.

8.1 Status of Species and Critical Habitat Likely to be Adversely Affected

This section examines the status of each species that would be 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 the species pages accessed through this NMFS Web site: [<https://www.fisheries.noaa.gov/welcome>].

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

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).

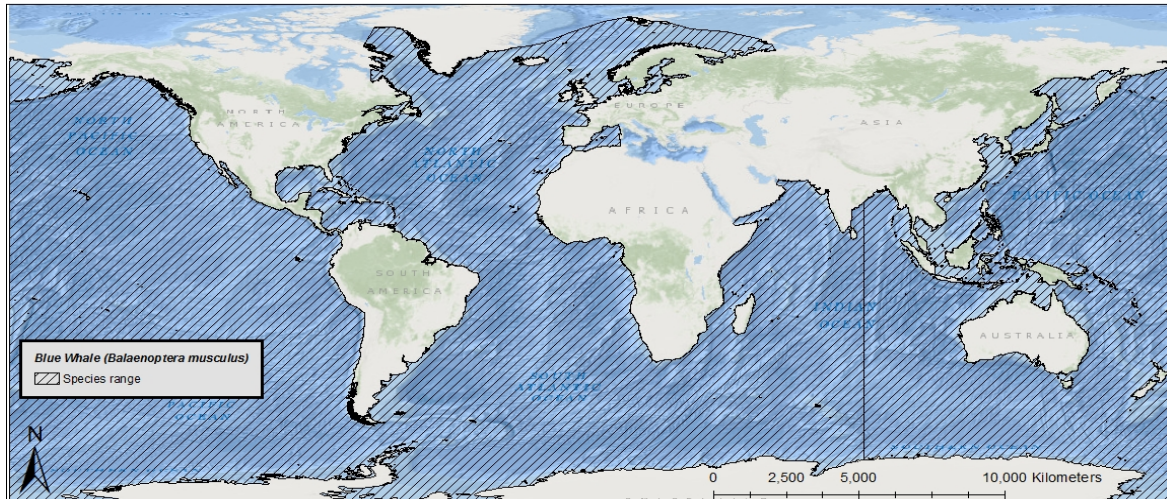


Figure 4. Map identifying the range of the blue whale.

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. 2016a), 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: the western North Atlantic stock, the eastern North Pacific stock (i.e., the U.S. West Coast), and the Central North Pacific stock in Hawaii and Alaska. Individuals from the Central North Pacific stock are likely to be affected by the proposed action.

8.1.1.1 Life History

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

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). Blue whales are separated into populations by ocean basin in the North Atlantic, North Pacific, and Southern Hemisphere. Current estimates indicate approximately 5,000 to 12,000 blue whales globally, and about 2,500 in the North Pacific (IWC 2007b). The eastern North Pacific stock has a population estimate of $N = 1,647$ ($N_{\min} = 1,551$) (Calambokidis and Barlow 2013; Muto et al. 2018). Wade and Gerrodette (1993) estimated 1,400 blue whales in the eastern tropical Pacific; while Bradford and Lyman (2013) estimated 81 blue whales in the Hawaiian exclusive economic zone.

An overall population growth rate for the species or a growth rate for the Central North Pacific 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 Pacific Ocean, blue whales range from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California to Costa Rica in the east. Blue whales in the Central North Pacific stock feed along the Aleutian Islands and migrate to the offshore waters north of Hawaii in winter (Carretta et al. 2014).

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 hertz (Hz), with dominant frequencies from 16 to 25 Hz, and songs that span frequencies from 16 to 60 Hz that last up to 36 seconds repeated every one to two minutes (see Cummings and Thompson 1971b; 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 1 μ Pa, but may reach 195 dB re 1 μ Pa (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 μ Pa_{rms} at 1 m in the 17 to 30 Hz range and pygmy blue whale calls at 175 ± 1 dB re: 1 μ Pa_{rms} at 1 meter in the 17 to 50 Hz range. Source levels around Iceland have been 158 to 169 dB re: 1 μ Pa_{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. 1995e).

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 1971b; 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 (Eds-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 Pacific, at least 9,500 whales were killed between 1910 and 1965. Commercial whaling no longer occurs, but blue whales are threatened by ship strikes, entanglement in fishing gear, pollution, harassment due to whale watching, and reduced prey abundance and habitat degradation due to climate change. Because there is not enough data to assess population trends of blue whales in the Central North Pacific stock, we are not able to evaluate the blue whales' resiliency.

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.

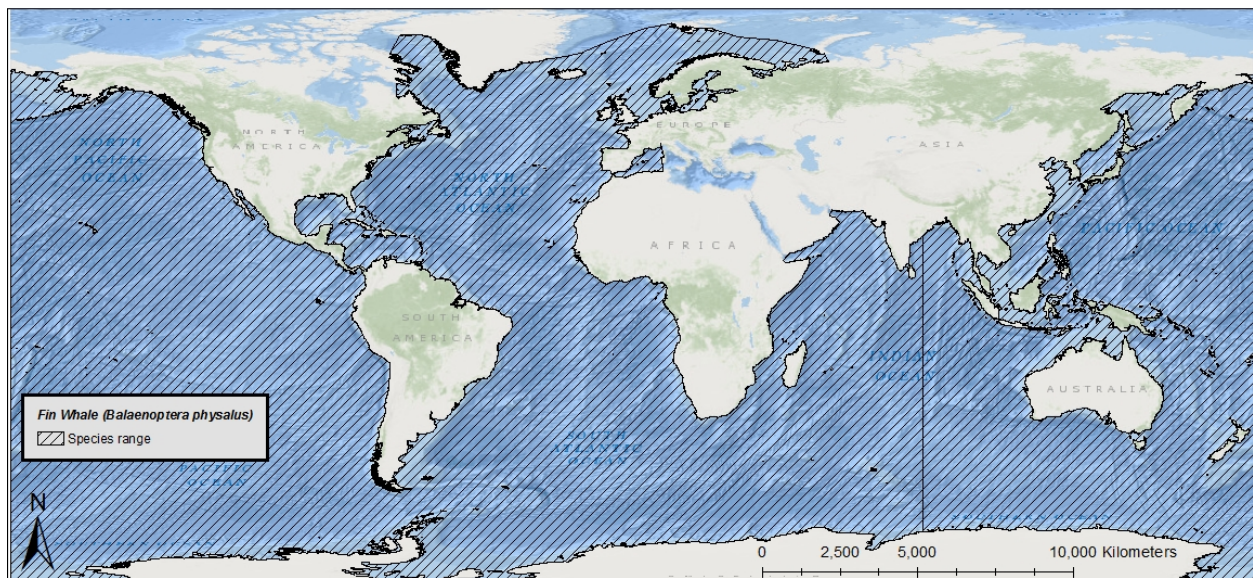


Figure 5. Map identifying the range of the fin whale.

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).

Information available from the recovery plan (NMFS 2010b), recent stock assessment reports (Carretta et al. 2018; Muto et al. 2018; Waring et al. 2016a), 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, eighty to ninety years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between six and ten years of age with an average calving interval of two to three years. They mostly inhabit deep, offshore waters of all major oceans. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed. 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.

The pre-exploitation estimate for the fin whale population in the North Pacific was 42,000 to 45,000 (Ohsumi 1974). In the North Pacific, at least 74,000 whales were killed between 1910 and 1975. Fin whales in the Northeast Pacific (near the western Aleutian islands and in the Bering Sea) have limited abundance data available, but the minimum population estimate is 2,254, which is likely an underestimate (Muto et al. 2018). Fin whales are considered rare in Hawaii. Bradford et al. (2017a) estimated 154 fin whales in Hawaiian waters.

There is no population trend information available for fin whales in Hawaii (Carretta et al. 2018). For the Northeast Pacific stock, there is limited population trend data available. One estimate for fin whales south of the Alaska Peninsula gives an annual increase of 4.8 percent, but it is not possible to apply this estimate to the entire stock.

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 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. 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. (1995b) reported the most common sound as a one 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 $1\mu\text{Pa}\cdot\text{m}$ (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 one second and contains twenty cycles (Tyack 1999).

Although their function is still debated, low-frequency fin whale vocalizations travel over long distances and may aid in long-distance communication (Edds-Walton 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. 1995e).

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. Fin whales may be killed under “aboriginal subsistence whaling” in Greenland, under Japan’s scientific whaling program, and Iceland’s formal objection to the Commission’s ban on commercial whaling. Additional threats include ship strikes, reduced prey availability due to overfishing or climate change, and noise. Fin whales in California, Oregon, and Washington have a relatively large population size and increasing trend may provide some resilience to current threats, but the population is still well below pre-harvest levels.

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 Eastern North Pacific are found off the coasts of California, Oregon, and Washington, and into Alaska. Sei whales are also found in the Hawaii exclusive economic zone.

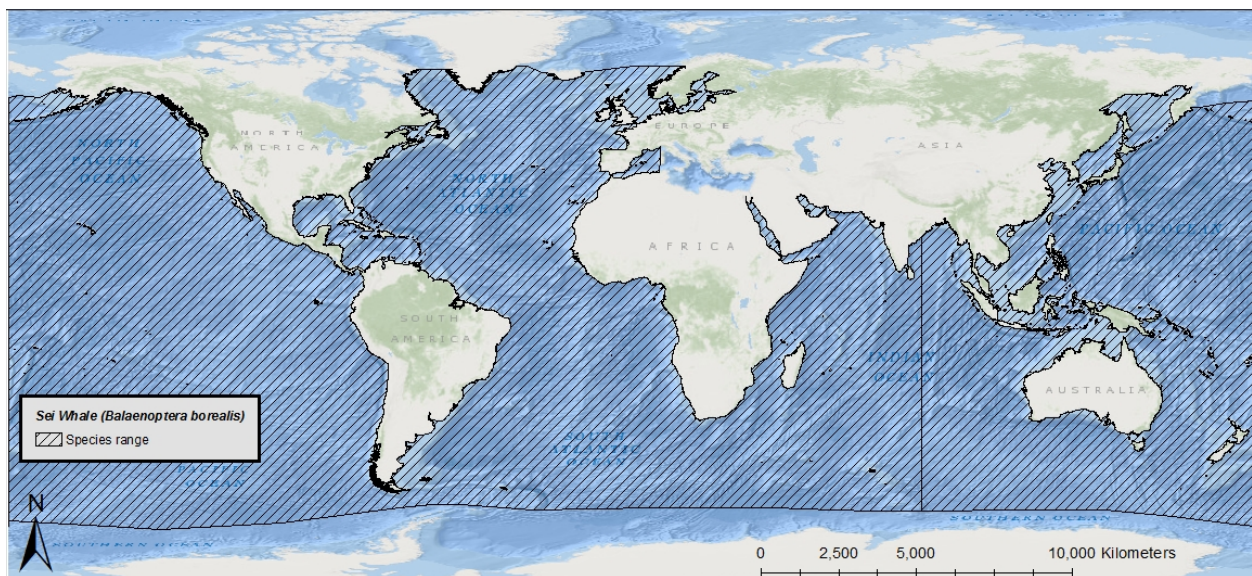


Figure 6. Map identifying the range of the sei whale.

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. 2016a) (Muto et al. 2018), and status review (NMFS 2012b) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.3.1 Life History

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

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.

Models indicate that total sei whale abundance declined from 42,000 to 8,600 individuals between 1963 and 1974 in the North Pacific. Sei whale abundance in the Eastern North Pacific is estimated at 519 individuals ($N_{\min}=374$) (Barlow 2016). Summertime abundance estimates over a broader range in the central and eastern North Pacific (170°E and 135°W , north of 40°N) give an estimate of 29,632 ($\text{CV}=0.242$) (Hakamada et al. 2017). Bradford et al. (2017a) estimated that there were 391 individuals ($\text{CV}=0.9$) ($N_{\min}=204$) in the Hawaii stock. However, this survey took place in the summer and fall, when sei whales are expected to be at higher latitudes on feeding grounds, so this is possibly an underestimate.

Population growth rates for sei whales in the Eastern North Pacific or Hawaii stocks 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 one to three second durations (McDonald et al. 2005). Source

levels of 189 ± 5.8 dB re: 1 μ Pa 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 (four milliseconds) frequency module sweeps between 1.5 to 3.5 kHz (Thomson and Richardson 1995b).

8.1.3.4 Status

The sei whale is endangered because of past commercial whaling. Current threats include ship 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). In the North Pacific Ocean, sperm whales are found in deep waters from the equator to approximately 62°N.

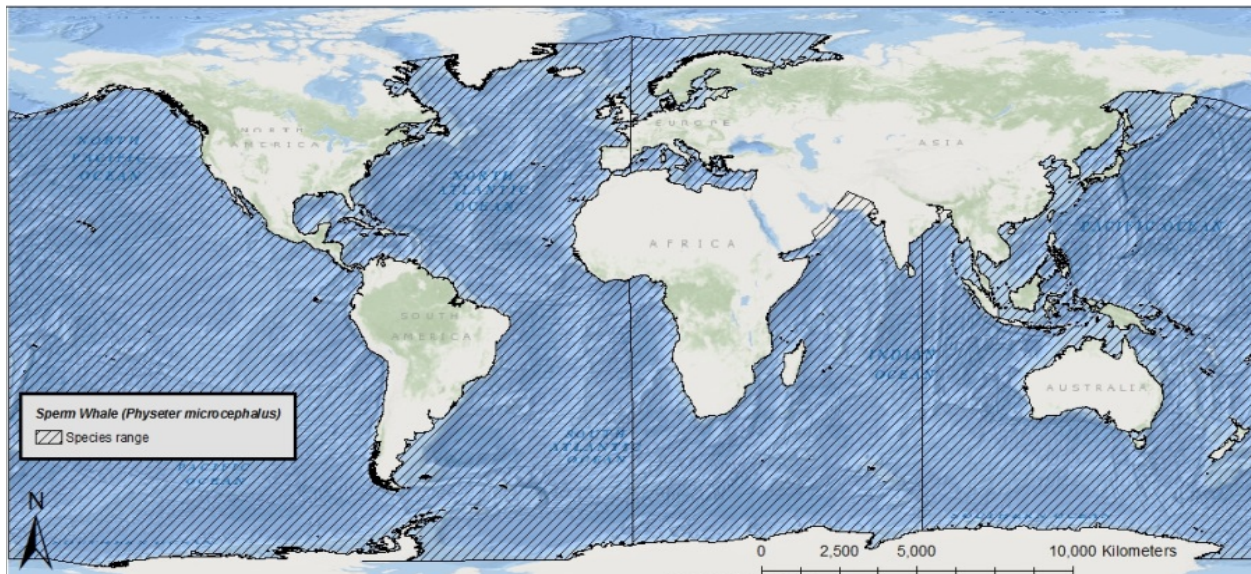


Figure 7. Map identifying the range of the sperm whale.

Sperm whales are the largest toothed whale and distinguishable from other whales by its extremely large head, which takes up to twenty-five percent to thirty-five 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; Muto et al. 2018; Waring et al. 2016a), and status review (NMFS 2015c) 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 two years. Sexual maturity is reached between seven and thirteen years of age for females with an average calving interval of four to six years. Male sperm whales reach full sexual maturity in their twenties. Sperm whales mostly inhabit areas with a water depth of 600 m (1,968 ft) or more, and are uncommon in waters less than 300 m (984 ft) 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 is no minimum abundance estimate available for sperm whales in the North Pacific stock. There are estimates for various portions of the stock however, including one for the western North Pacific (102,112 individuals), which is likely positively biased (Kato 1998), and between 129 and 135 individuals in the Gulf of Alaska (Rone et al. 2017). Another survey taking place in the western North Pacific (35°N to 51°N and 140°E to 170°E) estimated 15,929 sperm whales in the area in May and June, and 20,292 in the area in July and September (Hakamada et al. 2009). The minimum population estimate for the Hawaii stock of sperm whales is 3,478 individuals (Carretta et al. 2018).

There is insufficient data to evaluate trends in abundance and growth rates of sperm whales in the North Pacific or Hawaii 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 Gyllenstein 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 40°, only adult males venture into the higher latitudes near the poles. In shipboard and aerial surveys, they are commonly sighted near the 1,000-m 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: 1 μ Pa), although lower source level energy has been suggested at around 171 dB re: 1 μ Pa (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 two to four 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

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. Continued threats to sperm whale populations include ship strikes, entanglement in fishing gear, competition for resources due to overfishing, pollution, loss of prey and habitat due to climate change, and noise. 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 False Killer Whale Main Hawaiian Islands Insular Distinct Population Segment

False killer whales are distributed worldwide in tropical and temperate waters more than 1,000 m deep. The Main Hawaiian Islands Insular DPS of false killer whales is found in waters around the Main Hawaiian Islands (Figure 8).

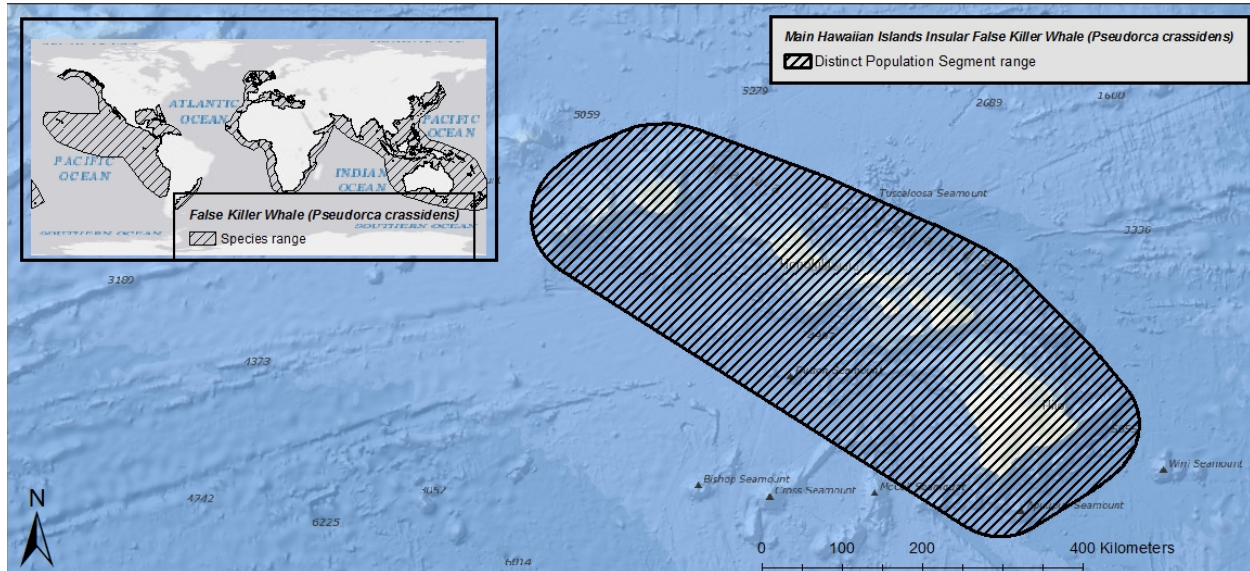


Figure 8. Map identifying the range of false killer whales and the Main Hawaiian Islands Insular distinct population segment of false killer whale.

The false killer whale is a toothed whale and large member of the dolphin family. False killer whales are distinguishable from other whales by having a small conical head without a beak, tall dorsal fin, and a distinctive bulge in the middle of the front edge of their pectoral fins. The Main Hawaiian Islands Insular DPS of false killer whale was originally listed as endangered on November 28, 2012 (77 FR 70915).

Information available from the most recent status review (NMFS 2010c) and recent stock assessment (Carretta et al. 2011) were used to summarize the status of the species as follows.

8.1.5.1 Life History

False killer whales can live, on average, for 60 years. They have a gestation period of 14 to 16 months, and calves nurse for 1.5 to two years. Sexual maturity is reached around 12 years of age with a very low reproduction rate and calving interval of approximately seven years. False killer whales prefer tropical to temperate waters that are deeper than 1,000 m. They feed during the day and at night on fishes and cephalopods, and are known to attack other marine mammals, indicating they may occasionally feed on them.

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 Main Hawaiian Islands Insular DPS of false killer whales.

Recent, unpublished estimates of abundance for two time periods, 2000 to 2004 and 2006 to 2009, were 162 and 151 respectively. Previously, the minimum population estimate for the Main Hawaiian Islands Insular DPS of false killer whale is the number of distinct individuals identified during the 2011 to 2014 photo-identification studies, or ninety-two false killer whales (Baird et

al. 2015). The most recent stock assessment report estimates abundance at 167 (CV=0.14), and a minimum population size of 149 individuals (Carretta et al. 2018).

A current estimated population growth rate for the Main Hawaiian Islands Insular DPS of false killer whales is not available at this time (Carretta et al. 2018). Reeves et al. (2009) suggested that the population may have declined during the last two decades, based on sighting data collected near Hawaii using various methods between 1989 and 2007. A modeling exercise conducted by Oleson et al. (2010b) evaluated the probability of actual or near extinction, defined as fewer than 20 animals, given measured, estimated, or inferred information on population size and trends, and varying impacts of catastrophes, environmental stochasticity and Allee effects. A variety of alternative scenarios were evaluated indicating the probability of decline to fewer than 20 animals within 75 years as greater than 20 percent. Although causation was not evaluated, all models indicated current declines at an average rate of negative nine percent since 1989.

The Main Hawaiian Islands Insular DPS of false killer whale is considered resident to the Main Hawaiian Islands and is genetically and behaviorally distinct compared to other stocks. Genetic data suggest little immigration into the Main Hawaiian Islands Insular DPS of false killer whale (Baird et al. 2012b). Genetic analyses indicated restricted gene flow between false killer whales sampled near the Main Hawaiian Islands, the Northwestern Hawaiian Islands, and pelagic waters of the Eastern and Central North Pacific.

NMFS currently recognizes three stocks of false killer whales in Hawaiian waters: the Main Hawaiian Islands Insular, Hawaii pelagic, and the Northwestern Hawaiian Islands. All false killer whales found within 40 km of the Main Hawaiian Islands belong to the insular stock and all false killer whales beyond 140 km belong to the pelagic stock. Animals belonging to the Northwest Hawaiian Islands stock are insular to the Northwest Hawaiian Islands (Bradford et al. 2012), however, this stock was identified by animals encountered off Kauai.

8.1.5.3 Vocalization and Hearing

Functional hearing in mid-frequency cetaceans, including Main Hawaiian Islands Insular DPS of false killer whales, is conservatively estimated to be between approximately 150 Hz and 160 kHz (Southall et al. 2007a). There are three categories of sounds that odontocetes make. The first includes echolocation sounds of high intensity, high frequency, high repetition rate, and very short duration (Au et al. 2000b). The second category of odontocete sounds is comprised of pulsed sounds. Burst pulses are generally very complex and fast, with frequency components sometimes above 100 kHz and average repetition rates of 300 per second (Yuen et al. 2007).

The final category of odontocete sounds is the narrowband, low frequency, tonal whistles (Au et al. 2000b; Caldwell et al. 1990). With most of their energy below 20 kHz, whistles have been observed with an extensive variety of frequency patterns, durations, and source levels, each of which can be repeated or combined into more complex phrases (Tyack and Clark 2000; Yuen et al. 2007).

In general, odontocetes produce sounds across the wildest band of frequencies. Their social vocalizations range from a few hundreds of Hz to tens of kHz (Southall et al. 2007a) with source levels in the range of 100 to 170 dB re: 1 μ Pa (see (Richardson et al. 1995d)). They also generate specialized clicks used in echolocation at frequencies above 100 kHz that are used to detect, localize and characterize underwater objects such as prey (Au et al. 1993). Echolocation clicks have source levels that can be as high as 229 dB re: 1 μ Pa peak-to-peak (Au et al. 1974).

Nachtigall and Supin (2008) investigated the signals from an echolocating false killer whale and found that the majority of clicks had a single-lobed structure with peak energy between 20 and 80 kHz false rather than dual-lobed clicks, as has been demonstrated in the bottlenose dolphin. U.S. Navy researchers measured the hearing of a false killer whale and demonstrated the ability of this species to change its hearing during echolocation (Nachtigall and Supin. 2008). They found that there are at least three mechanisms of automatic gain control in odontocete echolocation, suggesting that echolocation and hearing are a very dynamic process (Nachtigall and Supin. 2008). For instance, false killer whales change the focus of the echolocation beam based on the difficulty of the task and the distance to the target. The echo from an outgoing signal can change by as much as 40 dB, but the departing and returning signal are the same strength entering the brain (Nachtigall and Supin. 2008). The Navy demonstrated that with a warning signal, the false killer whale can adjust hearing by 15 dB prior to sound exposure (Nachtigall and Supin. 2008).

8.1.5.4 Status

The exact causes for the decline in the Main Hawaiian Islands Insular DPS of the false killer whale are not specifically known, but multiple factors have threatened and continue to threaten the population. Threats to the DPS include small population size, including inbreeding depression and Allee effects, exposure to environmental contaminants, competition for food with commercial fisheries, and hooking, entanglement, or intentional harm by fishermen. Recent photographic evidence of dorsal fin disfigurements and mouthline injuries suggest a high rate of fisheries interactions for this population compared to others in Hawaiian waters (Baird et al. 2015).

8.1.5.5 Critical Habitat

Critical habitat for the Main Hawaiian Islands Insular DPS of the false killer whale was designated on July 24, 2018, with an effective date of August 23, 2018 (83 FR 35062). The designation would include waters from the 45-m depth contour to the 3,200-m depth contour around the Main Hawaiian Islands. Parts of the designation are excluded for national security or economic reasons (Figure 9).

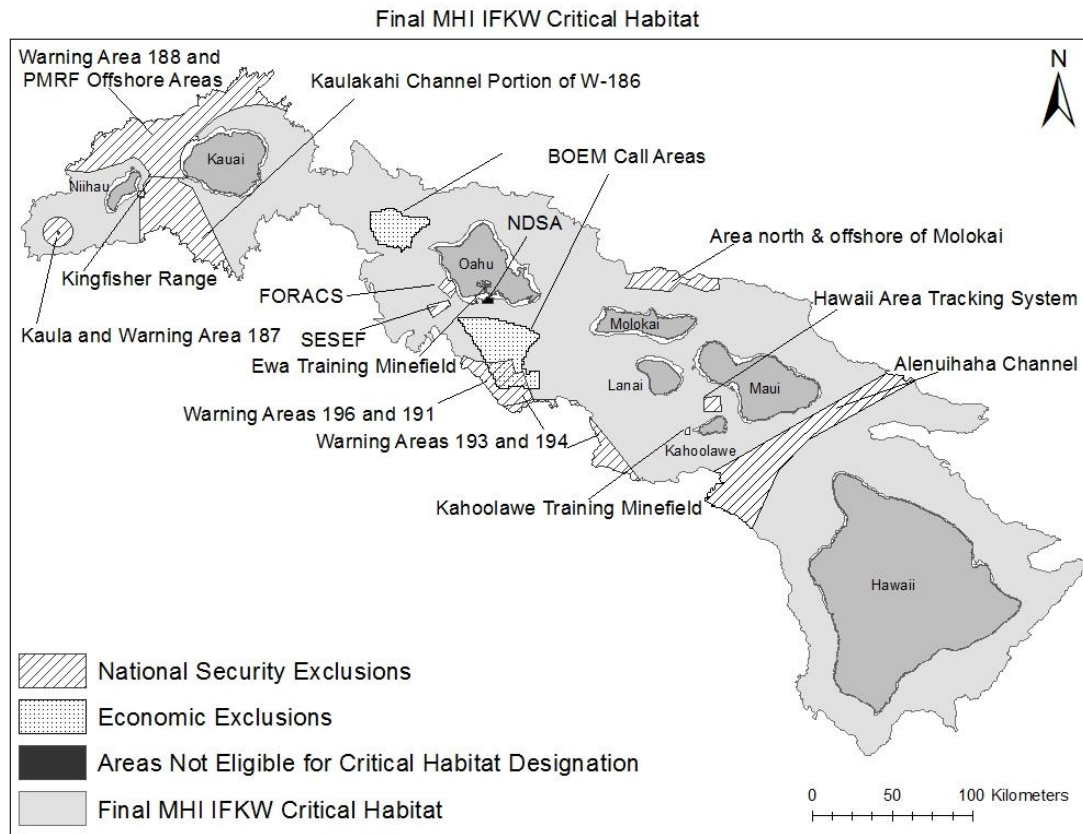


Figure 9. Critical habitat for the Main Hawaiian Islands Insular false killer whale.

The designated critical habitat includes one physical and biological feature essential for conservation of the species, with the following four characteristics:

- Adequate space for movement and use within shelf slope and habitat.
- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.
- Waters free of pollutants of a type and amount harmful to main Hawaiian Islands insular false killer whales.
- Sound levels that would not significantly impair false killer whales' use or occupancy.

8.1.5.6 Recovery Goals

There is currently no Recovery Plan available for the Main Hawaiian Islands insular DPS of the false killer whale.

8.1.6 Gray Whale

The gray whale is a baleen whale and the only species in the family Eschrichtiidae. There are two isolated geographic distributions of gray whales in the North Pacific Ocean: the Eastern

North Pacific stock, found along the west coast of North America, and the Western North Pacific or “Korean” stock, found along the coast of eastern Asia (Figure 10).

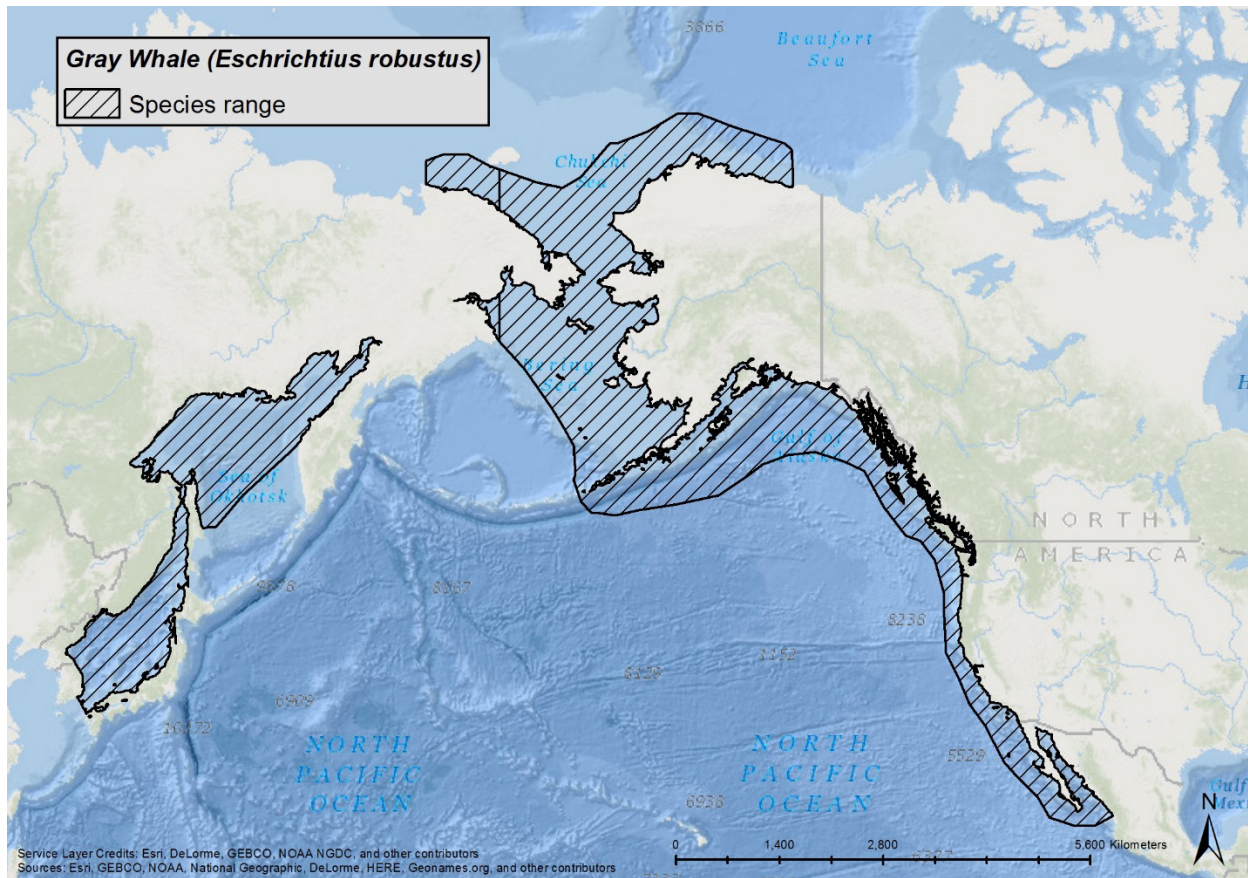


Figure 10. Map identifying the range of the gray whale.

Gray whales are distinguishable from other whales by a mottled gray body, small eyes located near the corners of their mouth, no dorsal fin, broad, paddle-shaped pectoral fins and a dorsal hump with a series of eight to fourteen small bumps known as “knuckles”.

The gray whale was originally listed as endangered on December 2, 1970 (35 FR 18319). The Eastern North Pacific stock was officially delisted on June 16, 1994 (58 FR 3121) when it reached pre-exploitation numbers. The Western North Pacific population of gray whales remained listed as endangered.

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

8.1.6.1 Life History

The average life span of gray whales is unknown but it is thought to be as long as eighty years. They have a gestation period of twelve to thirteen months, and calves nurse for seven to eight months. Sexual maturity is reached between six and twelve years of age with an average calving

interval of two to four years (Weller et al. 2009). Gray whales mostly inhabit shallow coastal waters in the North Pacific Ocean. Some Western North Pacific gray whales winter on the west coast of North America while others migrate south to winter in waters off Japan and China, and summer in the Okhotsk Sea off northeast Sakhalin Island, Russia, and off southeastern Kamchatka in the Bering Sea (Burdin et al. 2013). Gray whales travel alone or in small, unstable groups and are known as bottom feeders that eat “benthic” amphipods.

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 gray whale.

Photo-identification data collected between 1994 and 2011 on the Western North Pacific gray whale summer feeding ground off Sakhalin Island were used to calculate an abundance estimate of 140 whales for the non-calf population size in 2012 (Cooke et al. 2013). The minimum population estimate for the Western North Pacific stock is 135 individual gray whales on the summer feeding ground off Sakhalin Island.

The current best growth rate estimate for the Western North Pacific gray whale stock is 3.3 percent annually (Cooke et al. 2013).

There are often observed movements between individuals from the Eastern North Pacific stock and Western North Pacific stock; however, genetic comparisons show significant mitochondrial and nuclear genetic differences between whales sampled from each stock indicating genetically distinct populations (Leduc et al. 2002). A study conducted between 1995 and 1999 using biopsy samples found that Western North Pacific gray whales have retained a relatively high number of mitochondrial DNA haplotypes for such a small population. Although the number of haplotypes currently found in the Western North Pacific stock is higher than might be expected, this pattern may not persist into the future. Populations reduced to small sizes, such as the Western North Pacific stock, can suffer from a loss of genetic diversity, which in turn may compromise their ability to respond to changing environmental conditions (Willi et al. 2006) and negatively influence long-term viability (Frankham 2005; Spielman et al. 2004).

Gray whales in the Western North Pacific population are thought to feed in the summer and fall in the Okhotsk Sea, primarily off Sakhalin Island, Russia and the Kamchatka peninsula in the Bering Sea, and winter in the South China Sea (Figure 10). However, tagging, photo-identification, and genetic studies have shown that some whales identified as members of the Western North Pacific stock have been observed in the Eastern North Pacific, which may indicate that not all gray whales share the same migratory patterns.

8.1.6.3 Vocalization and Hearing

No data are available regarding Western North Pacific population gray whale hearing or communication. We assume that Eastern North Pacific population gray whale communication is

representative of the Western North Pacific population and present information stemming from this population. Individuals produce broadband sounds within the 100 Hz to 12 kHz range (Dahlheim et al. 1984; Jones and Swartz 2002; Thompson et al. 1979). The most common sounds encountered are on feeding and breeding grounds, where “knocks” of roughly 142 dB re: 1 μ Pa at 1 m (source level) have been recorded (Cummings et al. 1968; Jones and Swartz 2002; Thomson and Richardson 1995a). However, other sounds have also been recorded in Russian foraging areas, including rattles, clicks, chirps, squeaks, snorts, thumps, knocks, bellows, and sharp blasts at frequencies of 400 Hz to 5 kHz (Petrochenko et al. 1991). Estimated source levels for these sounds ranged from 167 to 188 dB re: 1 μ Pa at 1 m (Petrochenko et al. 1991). Low frequency (less than 1.5 kHz) “bangs” and “moans” are most often recorded during migration and during ice-entrapment (Carroll et al. 1989; Crane and Lashkari. 1996). Sounds vary by social context and may be associated with startle responses (Rohrkasse-Charles et al. 2011). Calves exhibit the greatest variation in frequency range used, while adults are narrowest; groups with calves were never silent while in calving grounds (Rohrkasse-Charles et al. 2011). Based upon a single captive calf, moans were more frequent when the calf was less than a year old, but after a year, croaks were the predominant call type (Wisdom et al. 1999).

Auditory structure suggests hearing is attuned to low frequencies (Ketten 1992a; Ketten 1992b). Responses of free-ranging and captive individuals to playbacks in the 160 Hz to 2 kHz range demonstrate the ability of individuals to hear within this range (Buck and Tyack 2000; Cummings and Thompson 1971a; Dahlheim and Ljungblad 1990; Moore and Clark 2002; Wisdom et al. 2001). Responses to low-frequency sounds stemming from oil and gas activities also support low-frequency hearing (Malme et al. 1986b; Moore and Clark 2002).

8.1.6.4 Status

The Western North Pacific gray whale is endangered as a result of past commercial whaling and may still be hunted under “aboriginal subsistence whaling” provisions of the International Whaling Commission. Current threats include ship strikes, fisheries interactions (including entanglement), habitat degradation, harassment from whale watching, illegal whaling or resumed legal whaling, and noise.

8.1.6.5 Critical Habitat

No critical habitat has been designated for the Western North Pacific gray whale. NMFS cannot designate critical habitat in foreign waters.

8.1.6.6 Recovery Goals

There is currently no Recovery Plan for the Western North Pacific gray whale. 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).

8.1.7 North Pacific Right Whale

North Pacific right whales are found in temperate and sub-polar waters of the North Pacific Ocean (Figure 11).

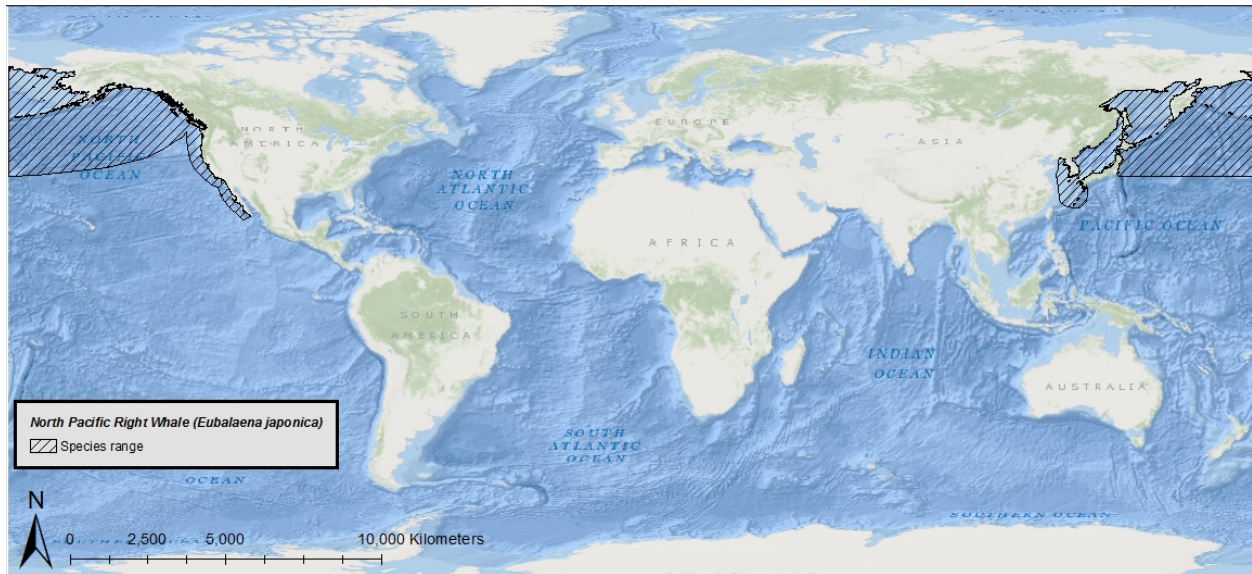


Figure 11. Map identifying the range of the endangered North Pacific right whale.

The North Pacific right whale is a baleen whale found only in the North Pacific Ocean and is distinguishable by a stocky body, lack of dorsal fin, generally black coloration, and callosities on the head region. The species was originally listed with the North Atlantic right whale (i.e., “Northern” right whale) as endangered on December 2, 1970 (35 FR 18319). The North Pacific right whale was listed separately as endangered on March 6, 2008 (73 FR 12024).

Information available from the recovery plan (NMFS 2013a) recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), and status review (NMFS 2012a) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.7.1 Life History

North Pacific right whales can live, on average, 50 or more years. They have a gestation period of approximately one year, and calves nurse for approximately one year. Sexual maturity is reached between 9 and 10 years of age. The reproduction rate of North Pacific right whales remains unknown. However, it is likely low due to a male-biased sex ratio that may make it difficult for females to find viable mates. North Pacific right whales mostly inhabit coastal and continental shelf waters. Little is known about their migration patterns, but they have been observed in lower latitudes during winter (Japan, California, and Mexico) where they likely calve and nurse. In the summer, they feed on large concentrations of copepods in Alaskan waters. North Pacific right whales are unique compared to other baleen whales in that they are

skim feeders meaning they continuously filtering through their baleen while moving through a patch of zooplankton.

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 North Pacific right whale.

The North Pacific right whale remains one of the most endangered whale species in the world. Their abundance likely numbers fewer than 1,000 individuals. Several lines of evidence indicate a total population size of less than 100. Based on photo-identification from 1998 to 2013 (Wade et al. 2011) estimated 31 individuals, with a minimum population estimate of 25.7 individuals. The most recent stock assessment report (Muto et al. 2018) reaffirms 31 individuals as the minimum population estimate for North Pacific right whales. Genetic data have identified 23 individuals based on samples collected between 1997 and 2011 (Leduc et al. 2012). There is currently no information on the population trend of North Pacific right whales.

As a result of past commercial whaling, the remnant population of North Pacific right whales has been left vulnerable to genetic drift and inbreeding due to low genetic variability. This low diversity potentially affects individuals by depressing fitness, lowering resistance to disease and parasites, and diminishing the whales' ability to adapt to environmental changes. At the population level, low genetic diversity can lead to slower growth rates, lower resilience, and poorer long-term fitness (Lacy 1997). Marine mammals with an effective population size of a few dozen individuals likely can resist most of the deleterious consequences of inbreeding (Lande 1991). It has also been suggested that if the number of reproductive animals is fewer than fifty, the potential for impacts associated with inbreeding increases substantially. Rosenbaum et al. (2000) found that historic genetic diversity of North Pacific right whales was relatively high compared to North Atlantic right whales (*E. glacialis*), but samples from extant individuals showed very low genetic diversity, with only two matrilineal haplotypes among the five samples in their dataset.

The North Pacific right whale inhabits the Pacific Ocean, particularly between 20 and 60 degrees latitude (Figure 11). Prior to exploitation by commercial whalers, concentrations of right whales in the North Pacific were found in the Gulf of Alaska, Aleutian Islands, south central Bering Sea, Sea of Okhotsk, and Sea of Japan. There has been little recent sighting data of right whales occurring in the central North Pacific and Bering Sea. However, since 1996, North Pacific right whales have been consistently observed in Bristol Bay and the southeastern Bering Sea during summer months.

8.1.7.3 Vocalization and Hearing

Given their extremely small population size and remote location, little is known about North Pacific right whale vocalizations (Marques et al. 2011). However, data from other right whales is informative. Right whales vocalize to communicate over long distances and for social

interaction, including communication apparently informing others of prey path presence (Biedron et al. 2005; Tyson and Nowacek 2005). Vocalization patterns amongst all right whale species are generally similar, with six major call types: scream, gunshot, blow, up call, warble, and down call (McDonald and Moore 2002; Parks and Tyack 2005). A large majority of vocalizations occur in the 300 to 600 Hz range with up and down sweeping modulations (Vanderlaan et al. 2003). Vocalizations below 200 Hz and above 900 Hz were rare (Vanderlaan et al. 2003). Calls tend to be clustered, with periods of silence between clusters (Vanderlaan et al. 2003). Gunshot bouts last 1.5 hours on average and up to seven hours (Parks et al. 2012a). Blows are associated with ventilation and are generally inaudible underwater (Parks and Clark 2007). Up calls are 100 to 400 Hz (Gillespie and Leaper 2001). Gunshots appear to be largely or exclusively male vocalization (Parks et al. 2005a).

Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001). Moans are usually produced within 10 m (33 ft) of the surface (Matthews et al. 2001). Up calls were detected year-round in Massachusetts Bay except July and August and peaking in April (Mussoline et al. 2012). Individuals remaining in the Gulf of Maine through winter continue to call, showing a strong diel pattern of up call and gunshot vocalizations from November through January possibly associated with mating (Bort et al. 2011; Morano et al. 2012; Mussoline et al. 2012). Estimated source levels of gunshots in non-surface active groups are 201 dB re: 1 μ Pa peak-to-peak (Hotchkiss et al. 2011). While in surface active groups, females produce scream calls and males produce up calls and gunshot calls as threats to other males; calves (at least female calves) produce warble sounds similar to their mothers' screams (Parks et al. 2003; Parks and Tyack 2005). Source levels for these calls in surface active groups range from 137 to 162 dB re: 1 μ Pa-m (rms), except for gunshots, which are 174 to 192 dB re: 1 μ Pa-m (rms) (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). Atlantic right whales shift calling frequencies, particularly of up calls, as well as increase call amplitude over both long and short term periods due to exposure to vessel noise (Parks and Clark 2007; Parks et al. 2005b; Parks et al. 2007a; Parks et al. 2011; Parks et al. 2010; Parks et al. 2012b; Parks et al. 2006), particularly the peak frequency (Parks et al. 2009). North Atlantic right whales respond to anthropogenic sound designed to alert whales to vessel presence by surfacing (Nowacek et al. 2003; Nowacek et al. 2004).

There is no direct data on the hearing range of North Pacific right whales. However, based on anatomical modeling, the hearing range for North Atlantic right whales is predicted to be from 10 Hz to 22 kHz with functional ranges probably between 15 Hz to 18 kHz (Parks et al. 2007b).

8.1.7.4 Status

The North Pacific right whale is endangered as a result of past commercial whaling. Prior to commercial whaling, abundance has been estimated to have been more than 11,000 individuals. Current threats to the survival of this species include hunting, ship strikes, climate change, and fisheries interactions (including entanglement). The resilience of North Pacific right whales to future perturbations is low due to its small population size and continued threats. Recovery is not

anticipated in the foreseeable future (several decades to a century or more) due to small population size and lack of available current information.

8.1.7.5 Recovery Goals

See the 2013 Final Recovery Plan for the North Pacific Right 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.

8.1.8 Humpback Whale Western North Pacific Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 12).

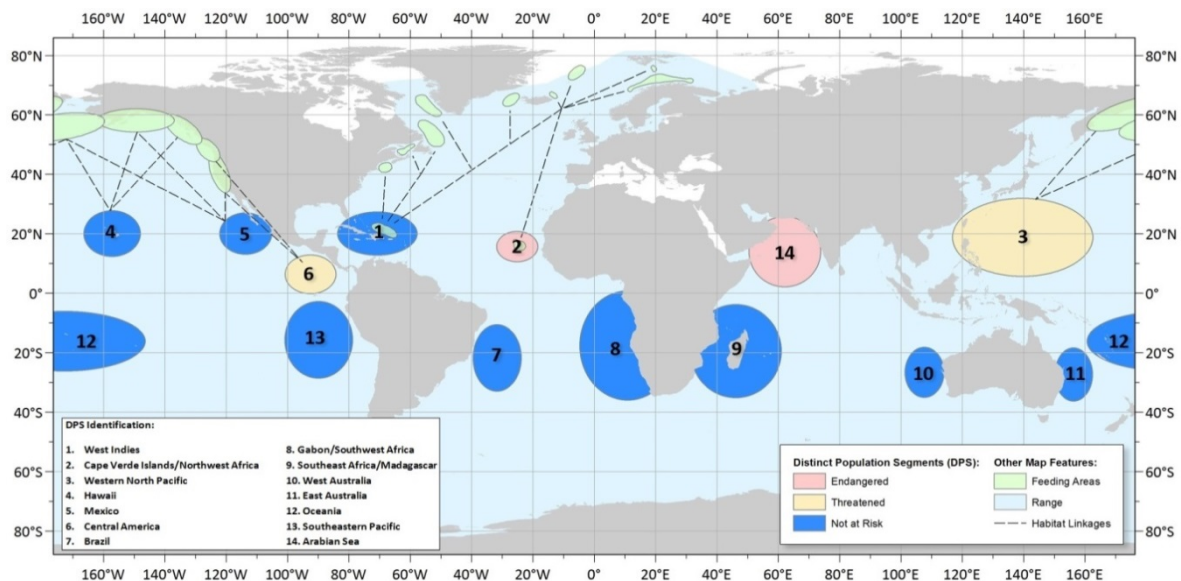


Figure 12: Map identifying 14 distinct population segments with one threatened and four endangered, based on primary breeding location of the humpback whale, their range, and feeding areas (Bettridge et al. 2015).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. The humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated fourteen DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (81 FR 62259).

Information available from the recovery plan (NMFS 1991), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016b), the status review (Bettridge et al.

2015), and the final listing (81 FR 62259) were used to summarize the life history, population dynamics and status of the species as follows.

8.1.8.1 Life History

Humpbacks can live, on average, fifty years. They have a gestation period of eleven to twelve months, and calves nurse for one year. Sexual maturity is reached between five to eleven years of age with an average calving interval of two to three years. Humpbacks mostly inhabit coastal and continental shelf waters. They winter at low latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpbacks exhibit a wide range of foraging behaviors and feed on a range of prey types, including: small schooling fishes, euphausiids, and other large zooplankton (Bettridge et al. 2015).

8.1.8.2 Population Dynamics

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

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Western North Pacific DPS is 1,059 (81 FR 62259).

A population growth rate is currently unavailable for the Western North Pacific humpback whale DPS.

For humpback whales, distinct population segments 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. Distinct population segments that have a total population five hundred individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Populations at low densities (less than one hundred) 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. The Western North Pacific DPS has less than 2,000 individuals total, and is made up of two subpopulations, Okinawa/Philippines and the Second West Pacific. Thus, while its genetic diversity may be protected from moderate environmental variance, it could be subject to extinction due to genetic risks due to low abundance (81 FR 62259, Bettridge et al. 2015).

The Western North Pacific DPS consists of humpback whales breeding/wintering in the area of Okinawa and the Philippines, another unidentified breeding area (inferred from sightings of whales in the Aleutian Islands area feeding grounds), and those transiting from the Ogasawara area. These whales migrate to feeding grounds in the northern Pacific, primarily off the Russian coast (Figure 12) (81 FR 62259).

8.1.8.3 Vocalization and Hearing

Humpback whale vocalization is much better understood than is hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144 to 174 dB (Au et al. 2006b; Au et al. 2000b; Frazer and Mercado Iii 2000; Richardson et al. 1995d; Winn et al. 1970b). Males also produce sounds associated with aggression, which are generally characterized by frequencies between 50 Hz to 10 kHz with most energy below 3 kHz (Silber 1986b; Tyack 1983b). Such sounds can be heard up to 9 km away (Tyack 1983b). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995d; Tyack 1983b). While in northern feeding areas, both sexes vocalize in grunts (25 Hz to 1.9 kHz), pulses (25 to 89 Hz) and songs (ranging from 30 Hz to 8 kHz but dominant frequencies of 120 Hz to 4 kHz), which can be very loud (175 to 192 dB re: 1 μ Pa at 1 m) (Au et al. 2000b; Erbe 2002b; Payne 1985; Richardson et al. 1995d; Thompson et al. 1986b). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995d). NMFS classified humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales can hear frequencies between 0.007 and 30 Hz (NOAA 2013). Houser et al. (2001) produced a mathematical model of humpback whale hearing sensitivity based on the anatomy of the humpback whale ear. Based on the model, they concluded that humpback whales would be sensitive to sound in frequencies ranging from 0.7 to 10 kHz, with a maximum sensitivity between 2 to 6 kHz.

Humpback whales are known to produce three classes of vocalizations: (1) “songs” in the late fall, winter, and spring by solitary males; (2) social sounds made by calves (Zoidis et al. 2008) or within groups on the wintering (calving) grounds; and (3) social sounds made on the feeding grounds (Thomson and Richardson 1995a). The best-known types of sounds produced by humpback whales are songs, which are thought to be reproductive displays used on breeding grounds and sung only by adult males (Clark and Clapham 2004; Gabriele and Frankel. 2002; Helweg et al. 1992; Schevill et al. 1964; Smith et al. 2008). Singing is most common on breeding grounds during the winter and spring months, but is occasionally heard in other regions and seasons (Clark and Clapham 2004; Gabriele and Frankel. 2002; Mcsweeney et al. 1989). Au et al. (2000a) noted that humpback whales off Hawaii tended to sing louder at night compared to the day. There is a geographical variation in humpback whale song, with different populations singing a basic form of a song that is unique to their own group. However, the song evolves over the course of a breeding season but remains nearly unchanged from the end of one season to the start of the next (Payne et al. 1983). The song is an elaborate series of patterned vocalizations that are hierarchical in nature, with a series of songs (‘song sessions’) sometimes lasting for hours (Payne and Mcvay 1971). Components of the song range from below 20 Hz up to 4 kHz, with source levels measured between 151 and 189 dB re: 1 μ Pa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006b; Winn et al. 1970b).

Social calls range from 20 Hz to 10 kHz, with dominant frequencies below 3 kHz (D'Vincent et al. 1985; Dunlop et al. 2008; Silber 1986b; Simao and Moreira 2005). Female vocalizations appear to be simple; Simao and Moreira (2005) noted little complexity.

“Feeding” calls, unlike song and social sounds are a highly stereotyped series of narrow-band trumpeting calls. These calls are 20 Hz to 2 kHz, less than one second in duration, and have source levels of 162 to 192 dB re: 1 μ Pa-m (D'Vincent et al. 1985; Thompson et al. 1986b). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986b). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs^{Error! Bookmark not defined.} (Stimpert et al. 2007). Underwater lunge behavior was associated with nocturnal feeding at depth and with multiple boats of broadband click trains that were acoustically different from toothed whale echolocation: Stimpert et al. (Stimpert et al. 2007) termed these sounds “mega-clicks” which showed relatively low received levels at the DTAGs (143 to 154 dB re: 1 μ Pa), with the majority of acoustic energy below 2 kHz.

In terms of functional hearing capability, humpback whales belong to low frequency cetaceans which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007a). Humpback whale audiograms using a mathematical model based on the internal structure of the ear estimate sensitivity is from 700 Hz to 10 kHz, with maximum relative sensitivity between 2 kHz and 6 kHz (Ketten and Mountain 2014). Research by Au et al. (2001) and Au et al. (2006c) off Hawaii indicated the presence of high frequency harmonics in vocalizations up to and beyond 24 kHz. While recognizing this was the upper limit of the recording equipment, it does not demonstrate that humpback whales can actually hear those harmonics, which may simply be correlated harmonics of the frequency fundamental in the humpback whale song. The ability of humpback whales to hear frequencies around 3 kHz may have been demonstrated in a playback study. Maybaum (1990b) reported that humpback whales showed a mild response to a handheld sonar marine mammal detection and location device with frequency of 3.3 kHz at 219 dB re: 1 μ Pa-m or frequency sweep of 3.1 to 3.6 kHz. In addition, the system had some low frequency components (below 1 kHz) which may have been an artifact of the acoustic equipment. This possible artifact may have affected the response of the whales to both the control and sonar playback conditions.

8.1.8.4 Status

Humpback whales were originally listed as endangered as a result of past commercial whaling, and the five DPSs that remain listed (Cape Verde Islands/Northwest Africa, Western North Pacific, Central American, Arabian Sea, and Mexico) have likely not yet recovered from this. Prior to commercial whaling, hundreds of thousands of humpback whales existed. Global abundance declined to the low thousands by 1968, the last year of substantial catches (IUCN 2012). Humpback whales may be killed under “aboriginal subsistence whaling” and “scientific permit whaling” provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), energy development, harassment

from whale watching, noise, harmful algal blooms, disease, parasites, and climate change. The species' large population size and increasing trends indicate that it is resilient to current threats, but the Western North Pacific DPS still faces a risk of extinction.

8.1.8.5 Critical Habitat

No critical habitat has been designated for humpback whales.

8.1.8.6 Recovery Goals

See the 1991 Final Recovery Plan for the Humpback Whale for complete down listing/delisting criteria for each of the four following recovery goals:

1. Maintain and enhance habitats used by humpback whales currently or historically.
2. Identify and reduce direct human-related injury and mortality.
3. Measure and monitor key population parameters.
4. Improve administration and coordination of recovery program for humpback whales.

8.1.9 Hawaiian Monk Seal

The Hawaiian monk seal is a large phocid ("true seal") that is one of the rarest marine mammals in the world. The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands (NWHI) and Main Hawaiian Islands (MHI) (Figure 13).

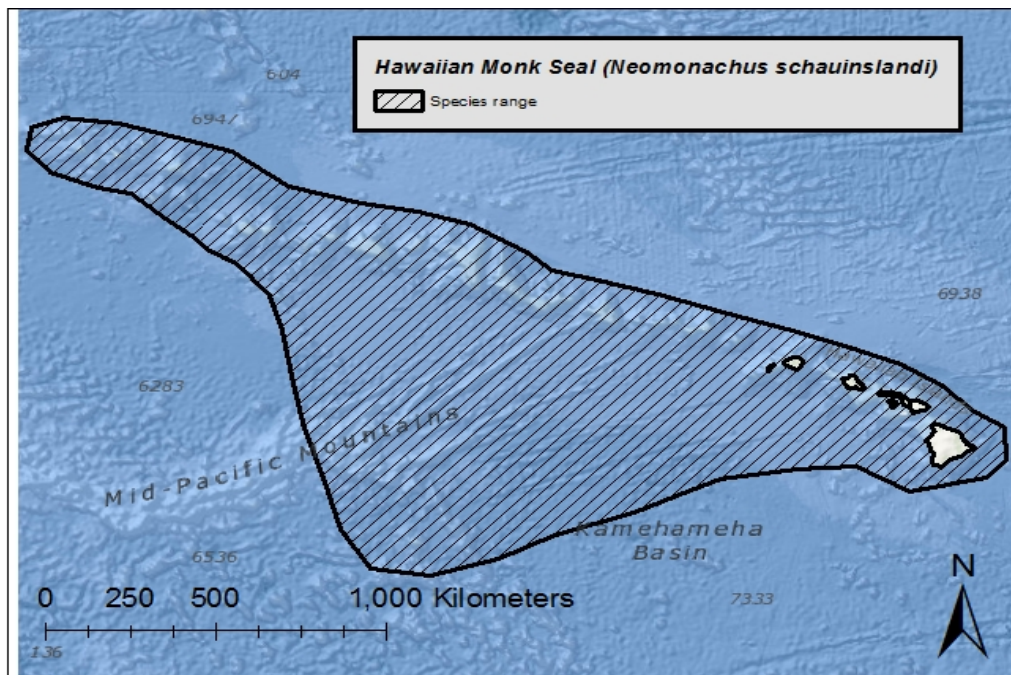


Figure 13. Map identifying the range of the endangered Hawaiian monk seal.

Hawaiian monk seals are silvery-grey with a lighter creamy coloration on their underside (newborns are black), they may also have light patches of red or green tinged coloration from attached algae. The Hawaiian monk seal was originally listed as endangered on November 23, 1976 (41 FR 51611).

Information available from the recovery plan (NMFS 2007b), recent stock assessment report (Carretta et al. 2016), and status review (NMFS 2007a) were used to summarize the status of the species as follows.

8.1.9.1 Life History

Hawaiian monk seals can live, on average, 25-30 years. Sexual maturity in females is reached around 5 years of age and it is thought to be similar for males but they do not gain access to females until they are older. They have a gestation period of 10 to 11 months, and calves nurse for approximately 1 month while the mother fasts and remains on land. After nursing, the mother abandons her pup and returns to the sea for 8 to 10 weeks before returning to beaches to molt. Males compete in a dominance hierarchy to gain access to females (i.e., guarding them on shore). Mating occurs at sea, however, providing opportunity for female mate choice. Monk seals are considered foraging generalist that feed primarily on benthic and demersal prey such as fish, cephalopods, and crustaceans. They forage in subphotic zones either because there areas host favorable prey items or because these areas are less accessible by competitors (Parrish et al. 2000).

8.1.9.2 Population Dynamics

The following is a discussion of the species' population and its variance over time. This section is broken down into: abundance, population growth rate, genetic diversity, and spatial distribution as it relates to the Hawaiian monk seal.

The entire range of the Hawaiian monk seal is located within U.S. waters. In addition to a small population found on the MHI, there are six main breeding subpopulations in the NWHI identified as Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. The latest published estimate of the total population of Hawaiian monk seals is 1,324 (Baker et al. 2016; Carretta et al. 2018), although unpublished data indicate a larger population estimate of 1,400 (NMFS 2017b). The most recent NMFS stock assessment report has a minimum abundance estimate of 1,261 animals for all sites combined (Carretta et al. 2018). These estimates are the sum of the estimated abundances from the Northwestern Hawaiian Islands and the Main Hawaiian Islands.

The overall abundance of Hawaiian monk seals has declined by over 68 percent since 1958. Since the only comprehensive range-wide abundance estimates available are from 2013 to 2015, it is not possible to determine a conclusive population trend for Hawaiian monk seals (Carretta et al. 2018). The point estimates from that time period are increasing (1,291: 2013; 1,309: 2014, and 1,324: 2015), but more range-wide abundance estimates are necessary before a reliable trend can be determined (Carretta et al. 2018).

Genetic analysis indicates the species is a single panmictic population, thus warranting a single stock designation (Schultz et al. 2011a). Genetic variation among monk seals is extremely low and may reflect a long-term history at low population levels and more recent human influences (Kretzmann et al. 2001; Schultz et al. 2009). In addition to low genetic variability, studies by

Kretzmann et al. (1997) suggest the species is characterized by minimal genetic differentiation among sub-populations and, perhaps some naturally occurring local inbreeding. The potential for genetic drift should have increased when seal numbers were reduced by European harvest in the 19th century, but any tendency for genetic divergence among sub-populations is probably mitigated by the inter-island movements of seals. Since the population is so small, there is concern about long-term maintenance of genetic diversity making it quite likely that this species will remain endangered for the foreseeable future.

8.1.9.3 Vocalization and Hearing

The information on the hearing capabilities of endangered Hawaiian monk seals is somewhat limited, but they appear to have their most sensitive hearing at 12 to 28 kHz. Below eight kHz, their hearing is less sensitive than that of other pinnipeds. Their sensitivity to high frequency sound drops off sharply above 30 kHz (Richardson et al. 1995c; Richardson et al. 1995d; Thomas et al. 1990). An underwater audiogram for Hawaiian monk seal, based on a single animals whose hearing may have been affected by disease or age, was best at 12 to 28 kHz and 60 to 70 kHz (Thomas et al. 1990). The hearing showed relatively poor hearing sensitivity, as well as a narrow range of best sensitivity and a relatively low upper frequency limit (Thomas et al. 1990). Schusterman et al. (2000) reviewed available evidence on the potential for pinnipeds to echolocate and indicated that pinnipeds have not developed specialized sound production or reception systems required for echolocation. Instead, it appears pinnipeds have developed alternative sensory systems (e.g., visual, tactile) to effectively forage, navigate, and avoid predators underwater.

8.1.9.4 Status

Hawaiian monk seals were once harvested for their meat, oil, and skins, leading to extirpation in the MHI and near-extinction of the species by the 20th century (Hiruki and Ragen 1992; Ragen 1999). The species partially recovered by 1960, when hundreds of seals were counted on NWHI beaches. Since then, however, the species has declined in abundance. Though the ultimate cause(s) for the decline remain unknown threats include food limitations in NWHI, entanglement in marine debris, human interactions, loss of haul-out and pupping beaches due to erosion in NWHI, disease outbreaks, shark predation, male aggression towards females, and low genetic diversity. With only approximately 1,112 individuals, remaining the species' resilience to further perturbation is low.

8.1.9.5 Recovery Goals

See the 2007 Final Recovery Plan for the Hawaiian monk seal for complete down listing/delisting criteria for each of the four following recovery goals.

1. Improve the survivorship of females, particularly juveniles, in sub-populations of the NWHI.
2. Maintain the extensive field presence during the breeding season in the NWHI.

3. Ensure the continued natural growth of the Hawaiian monk seal in the MHI by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human domestic animal diseases.
4. Reduce the probability of the introduction of infectious diseases into the Hawaiian monk seal population.

8.1.10 Loggerhead Sea Turtle North Pacific Ocean Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans. North Pacific Ocean DPS of loggerhead turtles are found throughout the Pacific Ocean, north of the equator. Their range extends from the West Coast of North America to eastern Asia (Figure 14).

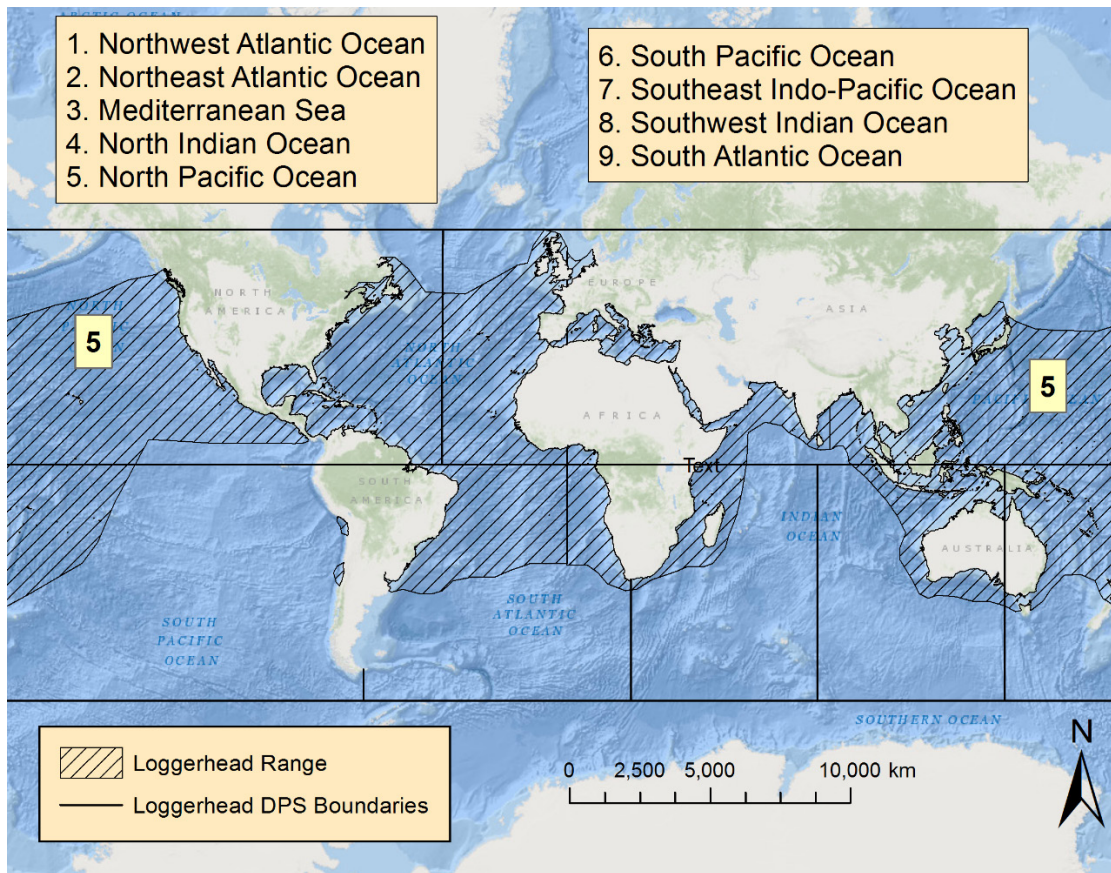


Figure 14. Map identifying the range of the North Pacific Ocean distinct population segment loggerhead turtle.

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

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

8.1.10.1 *Life History*

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

8.1.10.2 *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 Pacific Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560. The North Pacific Ocean DPS of loggerhead turtle has a nesting population of about 2,300 nesting females (Matsuzawa 2011). Loggerhead turtles abundance on foraging grounds off the Pacific Coast of the Baja California Peninsula, Mexico, was estimated to be 43,226 individuals (Seminoff 2014).

Overall, Gilman (2009) estimated that the number of loggerhead turtles nesting in the Pacific Ocean has declined by 80 percent in the past 20 years. There was a steep (50 to 90 percent) decline in the annual nesting population in Japan during the last half of the 20th century (Kamezaki 2003). Since then, nesting has gradually increased, but is still considered to be depressed compared to historical numbers, and the population growth rate is negative (-0.032) (Conant et al. 2009).

Recent mitochondrial DNA analysis using longer sequences has revealed a more complex population sub-structure for the North Pacific Ocean DPS of loggerhead turtle. Previously, five haplotypes were present, and now, nine haplotypes have been identified in the North Pacific Ocean DPS. This evidence supports the designation of three management units in the North Pacific Ocean DPS: (1) the Ryuku management unit (Okinawa, Okinoerabu, and Amami), (2) Yakushima Island management unit, and (3) Mainland management unit (Bousou, Enshu-nada, Shikoku, Kii, and Eastern Kyushu) (Matsuzawa et al. 2016). Genetic analysis of loggerhead

turtles captured on the feeding grounds of Sanriku, Japan, found only haplotypes present in Japanese rookeries (Nishizawa et al. 2014).

Loggerhead turtles are circumglobal, occurring throughout the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans, returning to their natal region for mating and nesting. Adults and sub-adults occupy nearshore habitat. While in their oceanic phase, loggerhead turtles undergo long migrations using ocean currents. Individuals from multiple nesting colonies can be found on a single feeding ground.

Hatchlings from Japanese nesting beaches use the North Pacific Subtropical Gyre and the Kuroshio Extension to migrate to foraging grounds. Two major juvenile foraging areas have been identified in the North Pacific Basin: Central North Pacific and off Mexico's Baja California Peninsula. Both of these feeding grounds are frequented by individuals from Japanese nesting beaches (Polovina 2013; Seminoff 2014).

8.1.10.3 *Vocalization and Hearing*

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

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

8.1.10.4 *Status*

Neritic juveniles and adults in the North Pacific Ocean DPS of loggerhead turtle are at risk of mortality from coastal fisheries in Japan and Baja California, Mexico. Habitat degradation in the form of coastal development and armoring pose a threat to nesting females. Based on these threats and the relatively small population size, the Biological Review Team concluded that the

North Pacific Ocean DPS of loggerhead turtle is currently at risk of extinction (Conant et al. 2009).

8.1.10.5 Critical Habitat

No critical habitat has been designated for the North Pacific Ocean DPS of loggerhead turtle.

8.1.10.6 Recovery Goals

NMFS has not prepared a Recovery Plan for the North Pacific Ocean DPS of loggerhead turtle.

8.1.11 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 15).

Leatherbacks are the largest living turtle, reaching lengths of six feet long, and weighing up to one 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 2013c) and available literature to summarize the life history, population dynamics and status of the species, as follows.

8.1.11.1 Life History

Age at maturity has been difficult to ascertain, with estimates ranging from five to twenty-nine years (Avens 2009; Spotila 1996). Females lay up to seven clutches per season, with more than sixty-five eggs per clutch and eggs weighing greater than 80 grams (Reina et al. 2002; Wallace 2007). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately fifty percent worldwide (Eckert et al. 2012). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback 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 thirty-three percent more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James 2005; Wallace 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).

8.1.11.2 *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. Leatherback populations in the Pacific are much lower than in the Atlantic, where the population has been increasing. 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 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 six percent per year since 1984 (Tapilatu 2013).

Analyses of mitochondrial DNA from leatherback sea turtles worldwide and in the Pacific indicate a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton 1999).

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. 2011b).

8.1.11.3 *Vocalization and Hearing*

Sea turtles are low-frequency hearing specialists, typically hearing frequencies from 30 to 2,000 Hz, with a range of maximum sensitivity between 100 and 800 Hz (Bartol 1999; Lenhardt 1994a; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found leatherback hatchlings capable of hearing underwater sounds at frequencies of 50 to 1,200 Hz (maximum sensitivity at 100 to 400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a).

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

8.1.11.4 *Status*

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. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide

reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, and sand extraction. Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea. Plastic ingestion is common in leatherbacks and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex), range (through expansion of foraging habitat), and habitat (through the loss of nesting beaches, because of sea-level rise). The species' resilience to additional perturbation is low. Leatherback populations in the Pacific are in particular danger due to the severe declines, and the threats have not abated (NMFS 2016b).

8.1.11.5 *Recovery Goals*

See the 1998 Recovery Plan for the U.S. Pacific leatherback sea turtles for complete down-listing/delisting criteria for the recovery goals (USFWS 1998). The following items were identified as criteria to be met to consider de-listing leatherbacks in the Pacific:

1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
2. Each stock must average 5,000 (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) females estimated to nest annually over six years.
3. Nesting populations at "source beaches" are either stable or increasing over a 25-year monitoring period.
4. Existing foraging areas are maintained as healthy environments.
5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.
6. All priority tasks have been implemented.
7. A management plan designed to maintain sustained populations of turtles is in place.

8.1.12 Olive Ridley Sea Turtle

The olive ridley turtle is a small, mainly pelagic, sea turtle with circumtropical distribution (Figure 16).

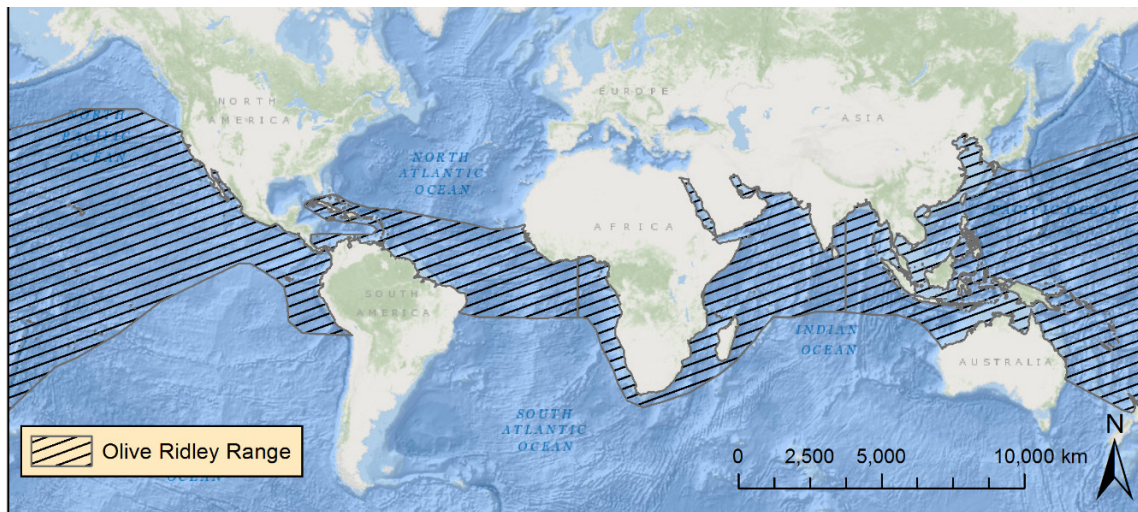


Figure 16. Map identifying the range of the olive ridley turtle.

Olive ridley turtles are olive or grayish-green in color, with a heart-shaped carapace. The species was listed under the ESA on July 28, 1978. The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range).

We used information available in the five year review (USFWS 2014) to summarize the life history, population dynamics, and status of the threatened olive ridley turtle, as follows.

8.1.12.1 Life History

Olive ridley turtle females mature at ten to 18 years of age. They lay an average of two clutches per season (three to six months in duration). The annual average clutch size is 100 to 110 eggs per nest. Olive ridley turtles commonly nest in successive years. Females nest in solitary or in arribadas, large aggregations coming ashore at the same time and location. The post-breeding behavior of olive ridley turtles in the eastern Pacific Ocean is unique in that they are nomadic, migrating across ocean basins. This contrasts with other sea turtle species, which typically migrate to a particular feeding ground after nesting. As adults, olive ridley turtles forage on crustaceans, fish, mollusks, and tunicates, primarily in pelagic habitats.

8.1.12.2 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 threatened range-wide population of the olive ridley turtle and endangered Pacific coast of Mexico breeding population of the olive ridley turtle (USFWS 2014).

Olive ridley turtles are thought to be the most abundant species of sea turtle, and can be found in the Atlantic, Indian, and Pacific Oceans. There is no global estimate of olive ridley turtle abundance, and we rely on nest counts and nesting females to estimate abundance in each of the

ocean basins, described below. Shipboard transects along the Mexico and Central America coasts between 1992 and 2006 indicate an estimated 1,390,000 adults. There are six primary arribada nesting beaches in Mexico; the largest begin La Escobilla, with about 1,000,000 nesting females annually. There are several monitored nesting beaches where solitary nesting occurs. At Nuevo Vallarta, about 4,900 nests are laid annually.

There are no known arribada nesting beaches in western Pacific Ocean; however, some solitary nesting occurs in Australia, Brunei, Malaysia, Indonesia, and Vietnam. Data are lacking for many sites. Terengganu, Malaysia had ten nests in 1998 and 1999. Alas Purwo, Indonesia, had 230 nests annually from 1993 through 1998.

In the eastern Pacific Ocean (excluding breeding populations in Mexico), there are arribada nesting beaches in Nicaragua, Costa Rica, and Panama. La Flor, Nicaragua had 521,440 effective nesting females in 2008 through 2009; Chacocente, Nicaragua had 27,947 nesting females over the same period (Sanchez, J. O. et al *in* (Jones 2012). Two other arribada nesting beaches are in Nicaragua, Masachapa and Pochomil, but there are no abundance estimates available. Costa Rica hosts two major arribada nesting beaches, Ostional has between 3,564 and 476,550 turtles per arribada, and Nancite has between 256 and 41,149 sea turtles per arribada. Panama has one arribada nesting beach, with 8,768 turtles annually.

There are several solitary nesting beaches in the East Pacific Ocean (excluding breeding populations in Mexico); however, no abundance estimates are available for beaches in El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador. On Hawaii Beach in Guatemala, 1,004 females were recorded in 2005 (USFWS 2014).

Population growth rate and trend information for the threatened population of olive ridley turtles is difficult to discern owing to its range over a large geographic area, and a lack of consistent monitoring data in all nesting areas. Below, we present the any known population trend information for olive ridley turtles by ocean basin (USFWS 2014).

There are no arribada nesting beaches in the Western Pacific Ocean. Data are lacking for inconsistent for many solitary nesting beaches in the Western Pacific Ocean, so it is not possible to assess population trends for these sites. Nest counts at Alas Purwo, Indonesia, appear to be increasing, the nest count at Terengganu, Malaysia, is thought to be a decline from previous years.

Population trends at Nicaraguan arribada nesting beaches are unknown or stable (La Flor). Ostional, Costa Rica arribada nesting beach is increasing, while trends Nancite, Costa Rica, and Isla Canas, Panama, nesting beaches are declining. For most solitary nesting beaches in the East Pacific Ocean, population trends are unknown, except for Hawaii Beach, Guatemala, which is decreasing.

Based on the number of olive ridley turtles nesting in Mexico, populations appear to be increasing in one location (La Escobilla: from 50,000 nests in 1998 to more than 1,000,000 in

2000), decreasing at Chacahua, and stable at all others. At-sea estimates of olive ridley turtles off Mexico and Central America also support an increasing population trend.

Genetic studies have identified four main lineages for the olive ridley turtle: east India, Indo-Western Pacific, Atlantic, and the eastern Pacific. In the eastern Pacific Ocean, rookeries on the Pacific Coasts of Costa Rica and Mexico were not genetically distinct, and fine-scale population structure was not found when solitary and arribada nesting beaches were examined. There was no population subdivision among olive ridley turtles along the east India coastline. Low levels of genetic diversity among Atlantic French Guinea and eastern Pacific Baja California nesting sites are attributed to a population collapse caused by past overharvest (USFWS 2014).

Globally, olive ridley turtles can be found in tropical and sub-tropical waters in the Atlantic, Indian, and Pacific Oceans. The range of the endangered Pacific coast breeding population extends as far south as Peru and up to California. Olive ridley turtles of the Pacific coast breeding colonies nest on arribada beaches at Mismaloya, Ixtapilla, and La Escobilla, Mexico. Solitary nesting takes place all along the Pacific coast of Mexico. Major nesting arribada beaches are found in Nicaragua, Costa Rica, Panama, India, and Suriname.

8.1.12.3 *Vocalization and Hearing*

Sea turtles do not appear to use sound for communication, and there are no published recordings of olive ridley sea turtle vocalizations. There is not information on olive ridley turtle hearing. However, we assume that their hearing sensitivities will be similar to those of green, hawksbill, leatherback, and loggerhead turtles, whose best hearing sensitivity is in the low frequency range, with maximum sensitivity below 400 Hz and an upper hearing range not likely to exceed 2 kHz.

These hearing sensitivities are similar to those reported for two terrestrial species: pond and wood turtles. Pond turtles respond best to sounds between 200 and 700 Hz, with slow declines below 100 Hz and rapid declines above 700 Hz, and almost no sensitivity above 3,000 Hz (Wever 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

8.1.12.4 *Status*

It is likely that solitary nesting locations once hosted large arribadas; since the 1960s, populations have experienced declines in abundance of 50 to 80 percent. Many populations continue to decline. Olive ridley turtles continue to be harvested as eggs and adults, legally in some areas, and illegally in others. Incidental capture in fisheries is also a major threat. The olive ridley turtle is the most abundant sea turtle in the world; however, several populations are declining as a result of continued harvest and fisheries bycatch. The large population size of the range-wide population, however, allows some resilience to future perturbation.

In the first half of the 20th century, there was an estimated 10,000,000 olive ridley turtles nesting on the Pacific coast of Mexico. Olive ridley turtles became targeted in a fishery in Mexico and Ecuador, which severely depleted the population; there was an estimated 1,000,000 olive ridley

turtles by 1969. Olive ridley turtle breeding populations on the Pacific coast of Mexico were listed as endangered in response to this severe population decline. Legal harvest of olive ridley turtles has been prohibited, although illegal harvest still occurs. The population is threatened by incidental capture in fisheries, exposure to pollutants, and climate change. In spite of the severe population decline, the olive ridley turtle breeding populations on the Pacific coast of Mexico appear to be resilient, evidenced by the increasing population.

8.1.12.5 Critical Habitat

No critical habitat has been designated for the breeding population of the Pacific coast of Mexico or the range-wide, threatened population of olive ridley turtles.

8.1.12.6 Recovery Goals

There has not been a Recovery Plan prepared specifically for the range-wide, threatened population or breeding populations of the Pacific coast of Mexico of olive ridley turtles. The 1998 Recovery Plan was prepared for olive ridley turtles found in the U.S. Pacific. Olive ridley turtles found in the Pacific could originate from the Pacific Coast of Mexico or from another nesting population. As such, the recovery goals in the 1998 Recovery Plan for the U.S. Pacific olive ridley turtle can apply to both ESA-listed populations. See the 1998 Recovery Plan for the U.S. Pacific olive ridley turtles for complete downlisting/delisting criteria for their recovery goals. The following items were the recovery criteria identified to consider delisting:

1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
2. Foraging populations are statistically significantly increasing at several key foraging grounds within each stock region.
3. All females estimated to nest annually at source beaches are either stable or increasing for over ten years.
4. Management plan based on maintaining sustained populations for sea turtles in effect.
5. International agreements in place to protect shared stocks.

8.1.13 Green Sea Turtle North Pacific Distinct Population Segment

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters (Figure 17).

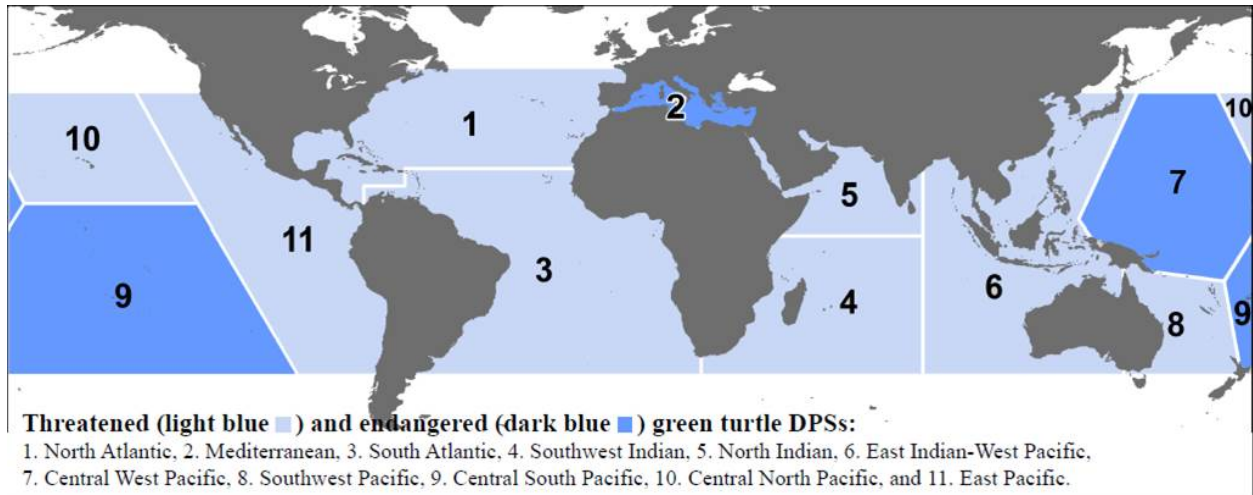


Figure 17. Map depicting range and distinct population segment boundaries for green turtles.

The Central North Pacific DPS of green turtle is found in the Pacific Ocean near the Hawaiian Archipelago and Johnston Atoll (Figure 18).

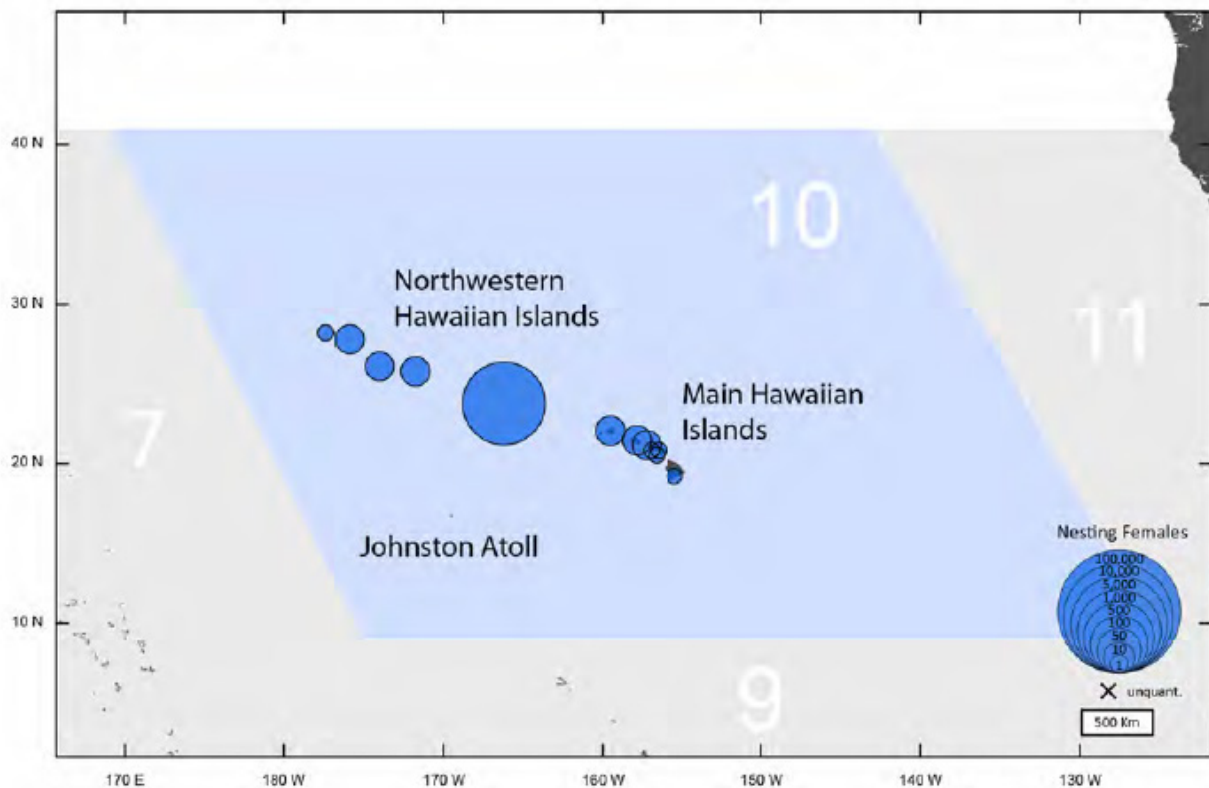


Figure 18. Geographic range of the Central North Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 pounds) and a straight carapace length of greater than 1 m (3.3 ft). 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 turtles as threatened or endangered under the ESA. The Central North Pacific DPS is listed as threatened.

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

8.1.13.1 *Life History*

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

8.1.13.2 *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 Central North Pacific DPS of green turtle.

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters. The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Green turtles in the Central North Pacific DPS are found in the Hawaiian Archipelago and Johnston Atoll (Figure 18). Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff 2015). There are 13 known nesting sites for the Central North Pacific DPS, with an estimated 3,846 nesting females. The Central North Pacific DPS of green turtle is very thoroughly monitored, and it is believed there is little chance that there are undocumented nesting sites. The largest nesting site is at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands, which hosts 96 percent of the nesting females for the Central North Pacific DPS. Nesting surveys have been conducted since 1973. Nesting abundance at East Island, French

Frigate Shoals, increases at 4.8 percent annually (Seminoff 2015). Lesser nesting sites are found throughout the Northwestern Hawaiian Islands and the Main Hawaiian Islands.

The majority of nesting for the Central North Pacific DPS is centered at one site on French Frigate Shoals, and there is little diversity in nesting areas. Overall, the Central North Pacific DPS has a relatively low level of genetic diversity and stock sub-structuring (Seminoff 2015). Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

8.1.13.3 *Vocalization and Hearing*

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 to 800 Hz (Bartol 1999; Lenhardt 1994a; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found green turtle juveniles capable of hearing underwater sounds at frequencies of 50 Hz to 1,600 kHz (maximum sensitivity at 200 to 400 Hz). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994a). Based upon auditory brainstem responses green turtles have been measured to hear in the 50 Hz to 1.6 kHz range (Dow et al. 2008), with greatest response at 300 Hz (Yudhana 2010); a value verified by Moein Bartol and Ketten (2006). Other studies have found greatest sensitivities are 200 to 400 Hz for the green turtle with a range of 100 to 500 Hz (Moein Bartol and Ketten 2006; Ridgway et al. 1969) and around 250 Hz or below for juveniles (Bartol 1999). However, Dow et al. (2008) found best sensitivity between 50 and 400 Hz.

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

8.1.13.4 *Status*

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

Green turtles in the Hawaiian Archipelago were subjected to hunting pressure for subsistence and commercial trade, which was largely responsible for the decline in the region. Though the practice has been banned, there are still anecdotal reports of harvest. Incidental bycatch in fishing

gear, ingestion of marine debris, and the loss of nesting habitat due to sea level rise are current threats to the population. Although these threats persist, the increase in annual nesting abundance, continuous scientific monitoring, legal enforcement and conservation programs are all factors that favor the resiliency of the Central North Pacific DPS of green turtle.

8.1.13.5 Critical Habitat

No critical habitat has been designated for the Central North Pacific DPS of green turtle.

8.1.13.6 Recovery Goals

See the 1998 Recovery Plan for the U.S. Pacific Populations of the Green Turtle for complete downlisting/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

8.1.14 Hawksbill Sea Turtle

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, sub-tropical oceans (Figure 19).

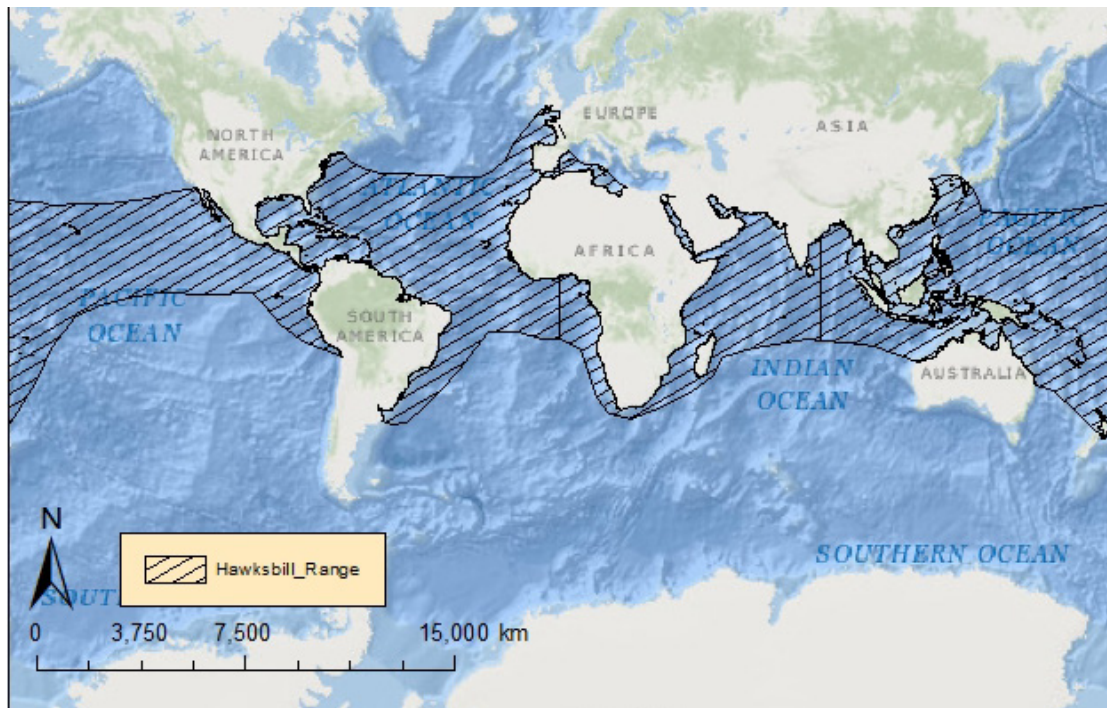


Figure 19. Map identifying the range of the endangered hawksbill turtle.

The hawksbill turtle has a sharp, curved, beak-like mouth and a “tortoise shell” pattern on its carapace, with radiating streaks of brown, black, and amber. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973.

We used information available in the five year reviews (NMFS 2013b; NMFS and USFWS 2007) to summarize the life history, population dynamics and status of the species, as follows.

8.1.14.1 *Life History*

Hawksbill turtles reach sexual maturity at 20 to 40 years of age. Females return to their natal beaches every two to five years to nest and nest an average of three to five times per season. Clutch sizes are large (up to 250 eggs). Sex determination is temperature dependent, with warmer incubation producing more females. Hatchlings migrate to and remain in pelagic habitats until they reach approximately 22 to 25 centimeters (cm; 8.7 to 9.8 inches [in]) in straight carapace length. As juveniles, they take up residency in coastal waters to forage and grow. As adults, hawksbill turtles use their sharp beak-like mouths to feed on sponges and corals. Hawksbill turtles are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Satellite tagged sea turtles have shown significant variation in movement and migration patterns. Distance traveled between nesting and foraging ranges from a few hundred to a few thousand kilometers (Horrocks et al. 2001; Miller et al. 1998).

8.1.14.2 *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 hawksbill turtle.

Surveys at 88 nesting sites worldwide indicate that 22,004 to 29,035 females nest annually (NMFS 2013b). In general, hawksbill turtles are doing better in the Atlantic and Indian Ocean than in the Pacific Ocean, where despite greater overall abundance, a greater proportion of the nesting sites are declining. In the Pacific Ocean, Hawaii hosts about 20 nesting females annually, less than 30 females nest annually on the American Samoa, and less than 10 females nest each year on Guam and the Northern Mariana Islands. An estimated 300 females nest in Micronesia annually (NMFS 2013b).

Population trends for hawksbill sea turtles in the Pacific Ocean are not known, but are considered to be declining (NMFS 2013b).

Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. Genetic analysis of hawksbill turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the western Atlantic, where the vast majority of nesting has been documented (McClellan 2010; Monzon-Arguello et al. 2010). Hawksbill turtles in the Caribbean Sea seem to have dispersed into separate populations (rookeries) after a bottleneck roughly 100,000 to 300,000 years ago (Leroux 2012).

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, sub-tropical waters of the Atlantic, Indian, and Pacific Oceans. In their oceanic phase, juvenile hawksbill turtles can be found in *Sargassum* mats; post-oceanic hawksbill turtles may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997).

8.1.14.3 *Vocalization and Hearing*

Sea turtles are low frequency hearing specialists, typically hearing frequencies from 30 Hz to 2 kHz, with a range of maximum sensitivity between 100 to 800 Hz (Bartol 1999; Lenhardt 1994a; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Piniak et al. (2012) found hawksbill turtle hatchlings capable of hearing underwater sounds at frequencies of between 50 Hz to 1.6 kHz (maximum sensitivity at 200 to 400 Hz).

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

8.1.14.4 *Status*

Long-term data on hawksbill turtle indicate that 63 sites have declined over the past 20 to 100 hundred years (historic trends are unknown for the remaining 25 sites). Recently 28 sites (68 percent) have experienced nesting declines, ten have experienced increases, three have remained stable, and 47 have unknown trends. The greatest threats to hawksbill turtles are overharvesting of sea turtles and eggs, degradation of nesting habitat, and fisheries interactions. Adult hawksbill turtles are harvested for their meat and carapace, which is sold as tortoiseshell. Eggs are taken at high levels, especially in Southeast Asia where collection approaches 100 percent in some areas. In addition, lights on or adjacent to nesting beaches are often fatal to emerging hatchlings and alters the behavior of nesting adults. The species' resilience to additional perturbation is low.

8.1.14.5 *Recovery Goals*

See the 1998 Recovery Plans for the U.S. Pacific populations of hawksbill turtles for complete downlisting/delisting criteria for the recovery goals. The following items were the top recovery actions identified to support in the Recovery Plan:

1. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters.
2. Each stock must average 1,000 females estimated to nest annually (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
3. All females estimated to nest annually at "source beaches" are either stable or increasing for 25 years.

4. Existing foraging areas are maintained as healthy environments.
5. Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.
6. All priority tasks have been implemented.
7. A management plan designed to maintain sustained populations of turtles is in place.
8. Ensure formal cooperative relationship with regional sea turtle management program.
9. International agreements are in place to protect shared stocks.

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

9.1 Climate Change

The 2014 Assessment Synthesis Report from the Working Groups on the Intergovernmental Panel on Climate Change (IPCC) concluded climate change is unequivocal (IPCC 2014). The report concludes oceans have warmed, with ocean warming the greatest near the surface (e.g., the upper 75 m [246 ft] have warmed by 0.11° Celsius per decade over the period 1971 through 2010) (IPCC 2014). Global mean sea level rose by 0.19 m (0.62 ft) 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 et al. 2012). Further, ocean acidity has increased by 26 percent since the beginning of the industrial era (IPCC 2014) and this rise has been linked to climate change. Climate change is also expected to increase the frequency of extreme weather and climate events including, but not limited to, cyclones, 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 and Isaac 2007a), recent research has indicated a range of consequences already occurring.

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

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

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). For example, rising sea levels are projected to inundate some sea turtle nesting beaches (Caut et al. 2009; Wilkinson and Souter 2008), change patterns of coastal erosion and sand accretion that are necessary to maintain those beaches, and increase the number of sea turtle nests destroyed by tropical storms and hurricanes (Wilkinson and Souter 2008). The loss of nesting beaches may have catastrophic effects on global sea turtle populations if they are unable to colonize new beaches, or if new beaches do not provide the habitat attributes (e.g., sand depth, temperature regimes, 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 et al. 2009a; Fuentes et al. 2010; Fuentes et al. 2009b; Glen et al. 2003). All of these temperature related impacts have the potential to significantly impact sea turtle reproductive success and ultimately, long-term species viability. Poloczanska et al. (2009) noted that extant sea turtle species have survived past climatic shifts, including glacial periods and 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 since the current rate of warming is very rapid, expected change might outpace sea turtles' ability to adapt.

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

This 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 Oceanic Temperature Regimes

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

The Pacific decadal oscillation is the leading mode of variability in the North Pacific and operates over longer periods than either El Niño or La Niña/Southern Oscillation events and is capable of altering sea surface temperature, surface winds, and sea level pressure (Mantua and Hare 2002; Stabeno et al. 2004). During positive Pacific decadal oscillations, the northeastern Pacific experiences above average sea surface temperatures while the central and western Pacific Ocean undergoes below-normal sea surface temperatures (Royer 2005). Warm Pacific decadal oscillation regimes, as occurs in El Niño events, tends to decrease productivity along the U.S. west coast, as upwelling typically diminishes (Childers et al. 2005; Hare et al. 1999). Recent sampling of oceanographic conditions just south of Seward, Alaska has revealed anomalously cold conditions in the Gulf of Alaska from 2006 through 2009, suggesting a shift to a colder

Pacific decadal oscillation phase. More research needs to be done to determine if the region is indeed shifting to a colder Pacific decadal oscillation phase in addition to what effects these phase shifts have on the dynamics of prey populations important to ESA-listed cetaceans throughout the Pacific action area. A shift to a colder decadal oscillation phase would be expected to impact prey populations, although the magnitude of this effect is uncertain.

There is some evidence to suggest that physical oceanographic patterns during the El Niño phenomenon affect the aggregations of marine debris in the northwest Hawaiian Islands. The North Pacific Ocean subtropical high convergence zone is an area where marine debris accumulates. In El Niño years, the subtropical high convergence zone becomes larger, more intense, and is located further south during winter, within the range of Hawaiian monk seals in the northwest Hawaiian Islands (Donohue and Foley 2007). Hawaiian monk seals experienced higher rates of entanglement during El Niño years, likely because of being exposed to the marine debris present in the subtropical high convergence zone.

In addition to period variation in weather and climate patterns that affect oceanographic conditions in the action area, longer terms trends in climate change and/or variability also have the potential to alter habitat conditions suitable for ESA-listed species in the action area on a much longer time scale. For example, from 1906 through 2006, global surface temperatures have risen 0.74° Celsius and this trend is continuing at an accelerating pace. Possible effects of this trend in climate change and/or variability for ESA-listed marine species in the action area include the alteration of community composition and structure, changes to migration patterns or community structure, changes to species abundance, increased susceptibility to disease and contaminants, and altered timing of breeding and nesting (Kintisch 2006; Learmonth et al. 2006; Macleod et al. 2005; McMahon and Hays 2006; Robinson et al. 2005). Climate change can influence reproductive success by altering prey availability, as evidenced by the low success of Northern elephant seals (*Mirounga angustirostris*) during El Niño periods (McMahon and Burton 2005) as well as data suggesting that sperm whale females have lower rates of conception following periods of unusually warm sea surface temperature (Whitehead et al. 1997). However, gaps in information and the complexity of climatic interactions complicate the ability to predict the effects that climate change and/or variability may have to these species from year to year in the action area (Kintisch 2006; Simmonds and Isaac 2007b).

9.3 Disease

Acute toxicity events may result in mass mortalities; repeated exposure to lower level contaminants may result in immune suppression and/or endocrine disruption (Atkinson et al. 2008). Pinnipeds may become exposed to infectious diseases (e.g., Chlamydia and leptospirosis) through polluted waterways (Aguirre et al. 2007). Infectious diseases are recognized as a significant threat to Hawaiian monk seals. In addition to polluted runoff water, other avenues for exposure include contact with other animals—marine mammals, and domestic and feral animals (NMFS 2016a). Toxoplasmosis has been observed in Hawaiian monk seals (Honnold et al. 2005), a disease that causes multiple organ dysfunction and failure. Recently, toxoplasmosis

cause the death of three Hawaiian monk seals on Oahu in May 2018; in total, 11 monk seals have died since 2001 as a result of the disease.¹ Morbilliviruses, such as canine distemper virus, phocine distemper virus, and cetacean morbillivirus, also pose threats to Hawaiian monk seals (Robinson et al. 2018). Because of its small population size, Hawaiian monk seals are especially at risk from infectious disease. In 2015, NOAA and partners worked to implement a vaccination program on Oahu (Robinson et al. 2018). The 2016 Hawaiian Monk Seal Management Plan identifies several activities to evaluate and reduce the risk of disease in monk seals (NMFS 2016a).

Mass mortality events of marine mammals, including cetaceans, have been reported more frequently since 1978, with viruses, bacteria, and parasites commonly listed as the cause (Gulland and Hall 2007). Morbillivirus was reported in a neonate female sperm whale that stranded and died in Oahu; the individual was also infected with the bacterial genus *Brucella* (West et al. 2015). In 1987, 14 humpback whales died in Cape Cod Bay, Massachusetts, after consuming mackerel containing a dinoflagellate toxin (Geraci et al. 1989).

Green sea turtles are susceptible to natural mortality from fibropapillomatosis disease. Fibropapillomatosis results in the growth of tumors on soft external tissues (flippers, neck, tail, etc.), the carapace, the eyes, the mouth, and internal organs (gastrointestinal tract, heart, lungs, etc.) (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). These tumors range in size from 0.1 cm (0.04 in) to greater than 30 cm (11.8 in) in diameter and may affect swimming, vision, feeding, and organ function (Aguirre et al. 2002; Herbst 1994; Jacobson et al. 1989). Presently, scientists are unsure of the exact mechanism causing this disease, but it is likely related to both an infectious agent, such as a virus (Herbst et al. 1995), and environmental conditions (e.g., habitat degradation, pollution, low wave energy, and shallow water) (Foley et al. 2005). Fibropapillomatosis is cosmopolitan, but it affects large numbers of animals in specific areas, including Hawaii and Florida (Herbst 1994; Jacobson 1990; Jacobson et al. 1991).

Fibropapillomatosis is the most significant cause of stranding and mortality in green turtles in Hawaii, accounting for 28 percent of strandings with an 88 percent mortality rate of afflicted stranded sea turtles (Chaloupka et al. 2008). While the disease appears to have regressed over time (Chaloupka et al. 2009b), it persists in the population at levels of spatial variability (Van Houtan et al. 2010). Van Houtan et al. (2010) also suggest a potential relationship exists between the expression of fibropapillomatosis and the State's land use, wastewater management practices, and invasive macro algae.

9.4 Invasive Species

Invasive species have been referred to as one of the top four threats to the world's oceans (Pughiuc 2010; Raaymakers 2003; Raaymakers and Hilliard 2002; Terdalkar et al. 2005; Wambiji et al. 2007). A variety of vectors are thought to have introduced non-native species

¹ <https://www.fisheries.noaa.gov/feature-story/disease-causes-three-hawaiian-monk-seal-deaths>

including, but not limited to, aquarium and pet trades, recreation, and ballast water discharges from ocean-going vessels. Common impacts of invasive species are alteration of habitat and nutrient availability, as well as altering species composition and diversity within an ecosystem (Strayer 2010).

Shifts in the base of food webs, a common result of the introduction of invasive species, can fundamentally alter predator-prey dynamics up and across food chains (Moncheva and Kamburska 2002), potentially affecting prey availability and habitat suitability for ESA-listed species. Invasive species have been implicated in the endangerment of 48 percent of ESA-listed species (Czech and Krausman 1997). States and the federal government (e.g., NOAA and U.S. Geological Survey) have management plans and are leading efforts to prevent and control the spread of invasive species.

9.5 Pollution

Anthropogenic activities such as discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture, and additional impacts from coastal development are known to degrade coastal waters utilized by ESA-listed marine mammals and sea turtles in the action area. Multiple municipal, industrial, and household sources as well as atmospheric transport introduce various pollutants such as pesticides, hydrocarbons, organochlorides, and other pollutants that may cause adverse health effects to ESA-listed marine mammals (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993; Ross 2002a). The accumulation of persistent pollutants through trophic transfer may cause mortality and sub-lethal effects including immune systems abnormalities, endocrine disruption and reproductive effects (Krahn et al. 2007a). Recent efforts have led to improvements in regional water quality in some parts of the action area, although the more persistent chemicals are still detected and are expected to endure for years (Grant and Ross 2002).

9.5.1 Marine Debris

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

Marine debris affects marine habitats and marine life worldwide, primarily by entangling or choking individuals that encounter it. Entanglement in marine debris can lead to injury, infection, and reduced mobility, increased susceptibility to predation, decreased feeding ability, fitness consequences, and mortality for all ESA-listed species in the action area. Entanglement can also result in drowning for air breathing marine species including sea turtles, cetaceans, and pinnipeds. Marine debris ingestion can lead to intestinal blockage, which can impact feeding

ability and lead to injury or death. Data on marine debris in some locations of the action area is largely lacking; therefore, it is difficult to draw conclusions as the extent of the problem and its impacts on populations of ESA-listed species.

Sea turtles can mistake plastic bags for jellyfish, which are eaten by sea turtle species in early life phases, and exclusively by leatherback turtles throughout their lives. One study found plastic in 37 percent of dead leatherback turtles and determined that nine percent of those deaths were a direct result of plastic ingestion (Mrosovsky et al. 2009). Other marine debris, including derelict fishing gear and cargo nets, can entangle and drown sea turtles of all life stages. In a study examining ingestion in 115 green and hawksbill turtles stranded in Queensland, Schuyler et al. (2012) found that the probability of debris ingestion was inversely correlated with size (curved carapace length), and when broken down into size classes, smaller pelagic sea turtles were significantly more likely to ingest debris than larger benthic feeding turtles. Parker et al. (2005) conducted a diet analysis of 52 loggerhead turtles collected as bycatch from 1990 to 1992 in the high seas drift gillnet fishery in the central north Pacific Ocean. The authors found that 34.6 percent of the individuals sampled had anthropogenic debris in their stomachs (e.g., plastic, Styrofoam, paper, rubber, etc.). Similarly, a study of green turtles found that 61 percent of those observed stranded had ingested some form of marine debris, including rope or string, which may have originated from fishing gear (Bugoni et al. 2001). In 2008, two sperm whales stranded along the California coast, with an assortment of fishing related debris (e.g., net scraps, rope) and other plastics inside their stomachs (Jacobsen et al. 2010). One whale was emaciated, and the other had a ruptured stomach. It was suspected that gastric impaction was the cause of both deaths. Jacobsen (2010) speculated that the debris likely accumulated over many years, possibly in the North Pacific gyre that would carry derelict Asian fishing gear into eastern Pacific waters (Jacobsen et al. 2010).

Plastic debris is a major concern because it degrades slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as polychlorinated biphenyls (PCBs) and DDT (dichlorodiphenyltrichloroethane). Fish, marine mammals, and sea turtles can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. In the North Pacific Subtropical Gyre it is estimated that the fishes in this area are ingesting 10,886,216 to 21,772,433 kilograms (12,000 to 24,000 U.S. tons) of plastic debris a year (Davison and Asch 2011). It is expected that marine mammals and sea turtles may be exposed to marine debris over the course of the action although the risk of ingestion or entanglement and the resulting impacts are uncertain at the time of this consultation.

9.5.2 Pesticides and Contaminants

Exposure to pollution and contaminants has the potential to cause adverse health effects in marine species. Marine ecosystems receive pollutants from a variety of local, regional, and international sources, and their levels and sources are therefore difficult to identify and monitor

(Grant and Ross 2002). Marine pollutants come from multiple municipal, industrial, and household as well as from atmospheric transport (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata 1993). Contaminants may be introduced by rivers, coastal runoff, wind, ocean dumping, dumping of raw sewage by boats and various industrial activities, including offshore oil and gas or mineral exploitation (Garrett 2004; Grant and Ross 2002; Hartwell 2004).

The accumulation of persistent organic pollutants, including polychlorinated-biphenyls, dibenzo-p-dioxins, dibenzofurans, and related compounds, through trophic transfer may cause mortality and sub-lethal effects in long-lived higher trophic level animals such as cetaceans (Waring et al. 2016b), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007b). Persistent organic pollutants may also facilitate disease emergence and lead to the creation of susceptible “reservoirs” for new pathogens in contaminated marine mammal populations (Ross 2002b). 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 (Law 2014) (Grant and Ross 2002; Mearns 2001).

Some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants (O'Hara and Rice 1996). Persistent organic pollutants were present in the blubber of Hawaiian monk seals in the main and Northwest Hawaiian Islands. Adult males had the highest levels of persistent organic pollutants compared to adult females and juveniles (Lopez et al. 2012).

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

Concentrations of PCBs are reportedly equivalent to those in some marine mammals, with liver and adipose levels of at least one congener being exceptionally high (PCB 209: 500 to 530 ng/g wet weight) (Davenport et al. 1990; Oros et al. 2009). Levels of PCBs found in green turtle eggs are considered far higher than what is fit for human consumption (Van De Merwe et al. 2009).

Organochlorines have the potential to suppress the immune system of loggerhead turtles and may affect metabolic regulation (Keller et al. 2006; Keller et al. 2004; Oros et al. 2009). These contaminants should cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007), and are known to depress immune function in loggerhead turtles (Keller et al. 2006). Females from sexual maturity through reproductive life should have lower levels of contaminants than males because contaminants are shared with progeny through egg formation.

Exposure to sewage effluent may also result in green turtle eggs harboring antibiotic resistant strains of bacteria (Al-Bahry et al. 2009).

9.5.3 Hydrocarbons

Exposure to hydrocarbons released into the environment via oil spills and other discharges pose risks to marine species. Marine mammals are generally able to metabolize and excrete limited amounts of hydrocarbons, but exposure to large amounts of hydrocarbons and chronic exposure over time pose greater risks (Grant and Ross 2002). Acute exposure of marine mammals to petroleum products causes changes in behavior and may directly injure animals (Geraci 1990). 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 ESA-listed species indirectly by reducing food availability.

Oil can also be hazardous to sea turtles, with fresh oil causing significant mortality and morphological changes in hatchlings. Sea turtles are known to ingest and attempt to ingest tar balls, which can block their digestive systems, impairing foraging or digestion and potentially causing death (NOAA 2003), ultimately reducing growth, reproductive success, as well as increasing mortality and predation risk (Fraser 2014). Tar balls were found in the digestive tracts of 63 percent of post hatchling loggerheads in 1993 following an oil spill and 20 percent of the same species and age class in 1997 (Fraser 2014). Oil exposure can also cause acute damage on direct exposure to oil, including skin, eye, and respiratory irritation, reduced respiration, burns to mucous membranes such as the mouth and eyes, diarrhea, gastrointestinal ulcers and bleeding, poor digestion, anemia, reduced immune response, damage to kidneys or liver, cessation of salt gland function, reproductive failure, and death (NOAA 2003; NOAA 2010; Vargo et al. 1986c; Vargo et al. 1986a; Vargo et al. 1986b). Nearshore spills or large offshore spills can oil beaches on which sea turtles lay their eggs, causing birth defects or mortality in the nests (NOAA 2003; NOAA 2010).

9.6 Scientific and Research Activities

Scientific research permits issued by the NMFS currently authorize studies on ESA-listed species in the Pacific Ocean, which may extend into portions of the action area for the proposed seismic survey. These activities may result in harassment, stress, and, in limited cases, injury or mortality.

Regulations for section 10(a)(1)(A) of the ESA allow issuance of permits authorizing take of certain ESA-listed species for the purposes of scientific research. Prior to the issuance of such a permit, the proposal must be reviewed for compliance with section 7 of the ESA. Scientific research permits issued by NMFS currently authorize studies on ESA-listed species in the Pacific Ocean, some of which occur in portions of the action area. Marine mammals and sea turtles have been the subject of field studies for decades. The primary objective of most of these field studies

has generally been monitoring populations or gathering data for behavioral and ecological studies. Over time, NMFS has issued dozens of permits on an annual basis for various forms of “take” of marine mammals and sea turtles in the action area from a variety of research activities.

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

Authorized Hawaiian monk seal research and enhancement activities include monitoring, survey, observation, capture, sedation, disentanglement, dehooking, tagging, specimen collection (e.g., blood, tissue, blubber sampling), ultrasound, vaccination, wound treatment, behavior modification, temporary captivity, translocation, and humane euthanasia of moribund seals. The research is intended to identify impediments to recovery, inform the design of conservation measures, and execute and evaluate those measures. The enhancement activities are designed to improve the survival and reproductive success of individual monk seals, with the intent to improve the status of the species.

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

There are no other seismic surveys for research purposes with a MMPA incidental take authorization from NMFS scheduled to occur in the U.S. exclusive economic zone of the Hawaiian Islands or the International waters in the Central Pacific Ocean in 2018.

9.7 Commercial Fisheries and Incidental Capture

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions include entanglement and entrapment, which can lead to fitness consequences or mortality as a result of injury or drowning. Indirect effects include reduced prey availability and destruction of habitat. Potential impacts of fisheries include overfishing of targeted species and bycatch, both of which negatively affect fish stocks and other marine resources. Bycatch is the capture of fish, marine mammals, sea turtles, marine birds, and other non-targeted species that occurs incidental to normal fishing operations. Use of mobile fishing gear, such as bottom trawls, disturbs the seafloor and reduces structural complexity. Indirect impacts of trawls include increased turbidity, alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing (i.e., lost fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris (discussed in detail previously in Section 9.5.1). Lost gill nets, purse seines, and long-lines may

foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Fisheries interactions are a major threat to pinnipeds through several mechanisms: prey reduction, intentional shootings, incidental bycatch, and entanglement in fishing gear. Reduced quantity or quality of prey appears to be a major threat to several pinniped species, as evidenced by population declines, reduced body size/condition, low birth rates, and high juveniles mortality rates (Baker 2008; Trites and Donnelly 2003). Pinnipeds are also intentionally shot by fishermen as a result of actual or perceived competition for fish. On the Main Hawaiian Islands, Hawaiian monk seals have been killed in recent years, with at least four individuals shot, and three dying from traumatic head injury (NMFS 2016a).

Hookings and entanglement in fishing gear represent major threats to Hawaiian monk seals. From 1976 to 2014, there were 140 documented reports of Hawaiian monk seal hooking and entanglements on the main Hawaiian Islands (NMFS 2016a). Over the time period of 1982 to 2006, entanglement in discarded fishing gear led to at least seven deaths and 32 serious injuries in the Northwest Hawaiian Islands ([Lowry et al. 2011](#)). In the Main Hawaiian Islands, at least six seals have drowned in gill nets since 1976; three of those were since 2006 (Leone 2010). Hooks often become imbedded in the mouth or in internal organs, killing the seal or preventing future foraging. Fishing may have indirectly helped the species as well: the large recreational fishery in the Main Hawaiian Islands may have reduced the number of large carnivorous fish in the area, inadvertently reducing inter-specific competition for monk seals ([Baker and Johanos 2004](#)).

Aside from actively fished gear, derelict fishing gear (accidentally lost or intentionally discarded or abandoned fishing lines, nets, pots, traps, or other gear associated with commercial or recreational fishing) also represents an entanglement risk for pinnipeds. Derelict gear is one of the primary threats to the Hawaiian monk seal, with annual rates of entanglement in fishing gear ranging from four to 78 percent of the total estimated population (Donohue and Foley 2007). In the Northwest Hawaiian Islands, an estimated 52 tons of derelict fishing gear accumulate annually (Dameron et al. 2007), and debris accumulates in high density in shallow reefs near Hawaiian monk seal haul outs (Boland and Donohue 2003).

Cetaceans are prone to bycatch in longline, trawl and purse sein fisheries, and large whales are prone to entanglement in trap or pot fisheries. Entanglement may also make whales more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed. From 1924 to 2015, there were 300 gray whale mortality or serious injury reported in the North Pacific Ocean, most (78.3 percent) the result of fisheries interactions (Wilkinson et al. 2017).

There is a lack of specific information on marine mammal incidental bycatch and fisheries interactions in the North Pacific Ocean over the Emperor Seamounts. However, the area is targeted by fishing vessels from Japan, Korea, Russia, New Zealand, and Belize (FAO 2009). The Emperor Seamount Chain Area represents a primary fishing ground for Japanese vessels, targeting pelagic armor head (*Pentaceros richardsoni*) and splendid alfonsio (*Beryx splendens*),

captured by trawl nets (Uchida and Tagami 1984). Bottom gillnet fisheries take place over other seamounts in the North Pacific where fishermen are unable to trawl. Other fisheries in the region include trap and pot fisheries for deep sea crabs, and longline fisheries targeting deep sea sharks and channeled rockfish (also called scorpionfish; *Setarches guentheri*) (FAO 2009). The presence of these fisheries at least poses the risk of large whale entanglement within this portion of the action area.

Large whale mortalities and serious injuries related to fisheries interactions occur throughout the U.S. waters of the Pacific Ocean. Between 2011 and 2015, records of 170 large whale human-caused injury or mortality were reported on the U.S. Pacific West Coast; 124 of these incidents involved entanglement in fishing gear (Carretta et al. 2017). Humpback whales and gray whales were the most common species reported (71 and 63 individuals, respectively), but fin, sei, blue, and sperm whales were also affected (15 individuals total over that same time period) (Carretta et al. 2017). Longline fishery interactions pose a threat to Main Hawaiian Island insular false killer whales (Baird et al. 2015). More, undocumented mortalities and serious injuries for these and other marine mammals found within the action areas have likely occurred.

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

Aquaculture has the potential to impact protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic, impacts to habitat and benthic organisms, and water quality (NMFS 2015a; NOAA 2017). Aquaculture in Hawaii represents a significant industry, with sales totaling \$40 million in 2011, mostly from the sale of algae².

Fisheries can have a profound influence on fish populations. In a study of retrospective data, Jackson et al. (2001) analyzed paleoecological records of marine sediments from 125,000 years ago to present, archaeological records from 10,000 years before the present, historical documents, and ecological records from scientific literature sources over the past century. Examining this long-term data and information, Jackson et al. (2001) concluded that ecological extinction caused by overfishing precedes all other pervasive human disturbance of coastal ecosystems, including pollution and anthropogenic climatic change. Fisheries bycatch has been identified as a primary driver of population declines in several groups of marine species,

² <http://hdoa.hawaii.gov/ai/aquaculture-and-livestock-support-services-branch/aquaculture-in-hawaii/>

including sharks, mammals, marine birds, and sea turtles (Wallace et al. 2010b). Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al. 2008). Many cetacean species (particularly fin and humpback whales) are known to feed on species of fish that are harvested by humans (Carretta et al. 2016). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations.

9.8 Historic and Current Harvest

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

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

Under current International Whaling Commission regulations, aboriginal subsistence whaling within the action area is permitted the Russian Federation (Siberia, gray and bowhead whales), and the U.S. (Alaska, bowhead and gray whales). It is the responsibility of national governments to provide the International Whaling Commission with evidence of the cultural and subsistence needs of their people. The Scientific Committee provides scientific advice on safe catch limits

for such stocks (IWC 2012). Based on the information on need and scientific advice, the International Whaling Commission then sets catch limits, recently in five-year blocks.

Scientific permit whaling has been carried out by Japan. Japan has issued scientific permits in the Antarctic and in the western North Pacific Ocean every year in recent years targeting Bryde's whales, fin whales, humpback whales, minke whales, and sperm whales.

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

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

Seals, sea lions, and fur seals have been hunted by humans for centuries for their fur, meat, and oil. Two species (Caribbean monk seal [*Monachus tropicalis*] and Japanese sea lion [*Zalophus japonicus*]) were hunted to extinction in the 20th century, while other species were hunted to near extinction (including the Hawaiian monk seal), and many species were severely depleted. The long-term effects of over-exploitation may have altered the species' distribution (with the majority of seals now residing in the Northwest Hawaiian Islands) and depleted its genetic diversity (Schultz et al. 2011b). While hunting was previously the primary cause of population decline among ESA-listed pinnipeds, it no longer represents a major threat. The hunting of Hawaiian monk seals is illegal, although intentional killings remain a threat (as described in Section 9.7). The reason behind these killings is not certain but may reflect growing resentment toward a species that is considered by some to be a competitor to fishermen, a nuisance to beach goers, and/or an invasive species that was introduced to the MHI by NMFS (Watson 2011).

Directed harvest of sea turtles and their eggs for food and other products has existed for years and was a significant factor causing the decline of green, hawksbill, Kemp's ridley, leatherback, loggerhead, and olive ridley turtles. At present, despite conservation efforts such as bans and moratoriums by the responsible governments, the harvest of sea turtles and their eggs still occurs in many locations throughout the action area. Countries including Papua New Guinea, Mexico, Peru, and the Philippines have made attempts to reduce the threats to sea turtles, but illegal harvesting still occurs. In some countries (e.g., Vietnam and Fiji), harvest of sea turtle meat and eggs remains unregulated. The harvest of leatherbacks in the South Pacific is especially problematic, and is a significant factor in that population's decline (USFWS 2013).

9.9 Vessel Strike

Ships have the potential to affect animals through strikes, noise, and disturbance by their physical presence. Vessel strike is a significant and widespread concern for the recovery of ESA-listed marine mammals and sea turtles. This threat is increasing as commercial shipping lanes cross important breeding and feeding habitats and as whale populations recover and populate new areas or areas where they were previously extirpated (Swingle et al. 1993; Wiley et al. 1995). As ships continue to become faster and more widespread, an increase in vessel interactions with marine mammals is expected. All sizes and types of vessels can hit whales, but most lethal and severe injuries are caused by ships 80 m (262.5 ft) or longer. For whales, studies show that the probability of fatal injuries from ship strikes increases as vessels operate at speeds above 26 km per hour (14 knots) (Laist et al. 2001). Evidence suggests that not all whales killed as a result of vessel strike are detected, particularly in offshore waters, and some detected carcasses are never recovered while those that are recovered may be in advanced stages of decomposition that preclude a definitive cause of death determination (Glass et al. 2010). Most whales killed by vessel strike likely end up sinking rather than washing up on shore, and it is estimated that 17 percent of vessel strikes are actually detected (Kraus et al. 2005). Therefore, it is likely that the number of documented cetacean mortalities related to vessel strikes is much lower than the actual number of mortalities associated with vessel strikes.

Vessel traffic within the action area can come from both private (e.g., commercial, recreational) and federal vessel (e.g., military, research), but traffic that is most likely to result in vessel strikes for large whales comes from commercial shipping.

The potential lethal effects of vessel strikes are particularly profound on species with low abundance. However, all large whale species have the potential to be affected by vessel strikes. From 2010 to 2014, along the U.S. West Coast, there were four reports of blue whale vessel strikes, and three fin whale vessel strikes (Carretta et al. 2016; Helker et al. 2016; Muto et al. 2016). From 1924 to 2015, there were 300 gray whale mortality or serious injury reported in the North Pacific Ocean, with vessel strikes accounting for 19.1 percent of those incidents (Wilkinson et al. 2017). These data represent only known mortalities and serious injuries; more, undocumented mortalities and serious injuries for these and other stocks found within the action area have likely occurred.

Vessel strikes have injured Hawaiian monk seals in the past, with at least two individuals found with injuries likely caused by being hit by a boat (NMFS 2007b). These individuals recovered from their injuries, but were unable to return to the wild and were sent to live in captivity. The actual extent of the risk of vessel strikes to Hawaiian monk seals is unknown at this time, but could potentially be significant given the small population size.

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

9.10 Anthropogenic Sound

Cetaceans generate and rely on sound to navigate, hunt, and communicate with other individuals and anthropogenic sound can interfere with these important activities (Nowacek et al. 2007). Anthropogenic sound in the action area may be generated by commercial and recreational vessels, sonar, aircraft, seismic exploration, in-water construction activities, wind farms, and other human activities. These activities occur to varying degrees throughout the year and may lead to behavioral disturbance or even physical damage to marine animals, both of which have the potential to negatively impact fitness. Behavioral disturbances may include changes in surfacing, diving, orientation, and vocalizations (Gomez et al. 2016; Nowacek et al. 2007). Physiological responses can include stress related changes such as increases in heart rate, respiratory rates, stress hormones, and temporary or permanent hearing threshold shifts (Kunc et al. 2016; Nowacek et al. 2007).

Commercial shipping traffic is a major source of low frequency anthropogenic sound in the action area (NRC 2003a) (Figure 20). Large vessels emit predominantly low frequency sound which overlaps with many mysticetes predicted hearing ranges (7 Hz to 35 kHz) (NOAA 2016) and may mask their vocalizations and cause stress (Rolland et al. 2012a). Studies also report broadband sound from large cargo ships above 2 kHz that may interfere with important biological functions of odontocetes, including foraging (Blair et al. 2016; Holt 2008a). Other commercial vessels (e.g., whale watching, fisheries, etc.) and recreational vessels also operate within the action area and may produce similar sounds, although to a lesser extent given their much small size. Nonetheless, even sound from small whale watching vessels can cause auditory masking, behavioral responses, and temporary threshold shifts in cetaceans (Nowacek et al. 2007). Anthropogenic sound from vessel traffic may be particularly prevalent in shallower waters (13 to 19 m [42.7 to 62.3 ft]). At greater foraging depths of 100 to 200 m (328.1 to 656.2 ft) (Croll et al. 2001; Goldbogen et al. 2011), less but still substantial vessel traffic sound can be

heard. Anthropogenic noise from vessel traffic within the action area can be seen in Figure 20 below.

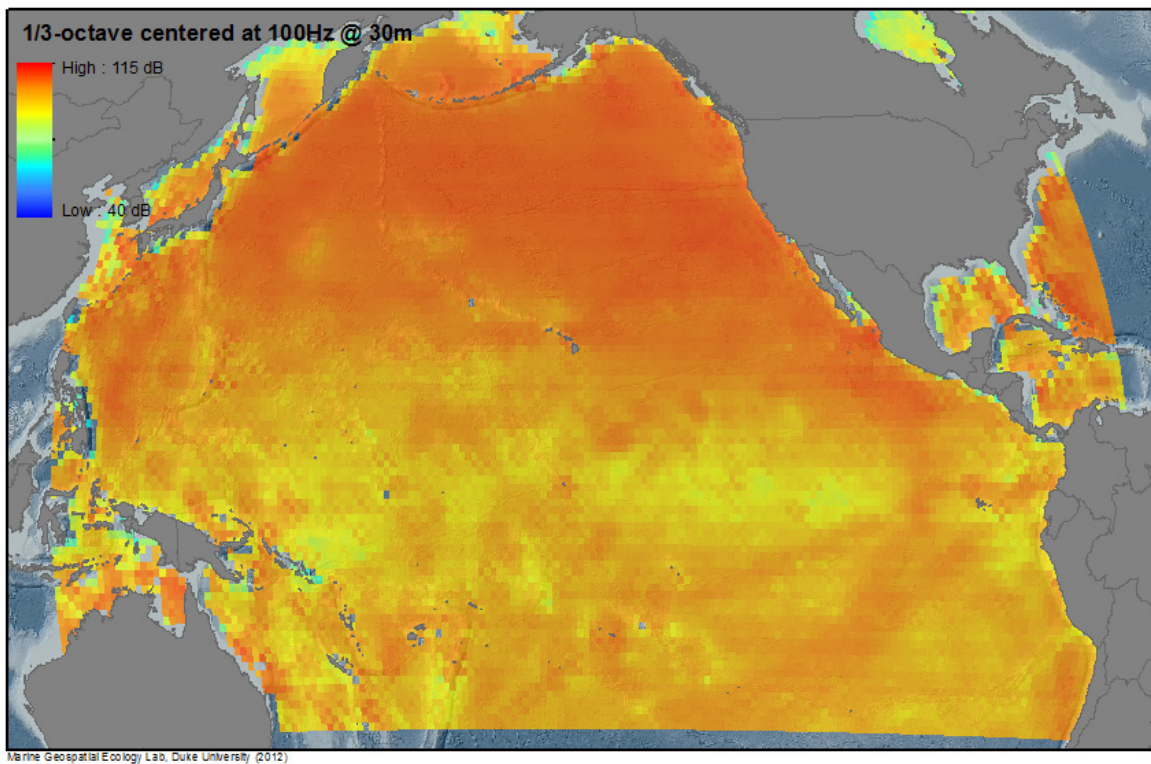


Figure 20. Vessel traffic sound in decibels, 1/3-octave centered at 100 Hertz at 30 meters, within the Pacific Ocean. Data from <http://cetsound.noaa.gov>.

Sonar systems are used on recreational, commercial, and military vessels and may also affect cetaceans (NRC 2003a). Although little information is available on potential effects of multiple commercial and recreational sonars to cetaceans, the distribution of these sounds will be small because of their short durations and the fact that the high frequencies of the signals attenuate quickly in seawater (Nowacek et al. 2007). However, military sonar, particularly low frequency active sonar, often produces intense sounds at high source levels, and these may impact cetacean behavior (Southall et al. 2016).

Aircraft within the action area may consist of small commercial or recreational airplanes or helicopters, to large commercial airliners. These aircraft produce a variety of sounds that could potentially enter the water and impact cetaceans. While it is difficult to assess these impacts, several studies have documented what appears to be minor behavioral disturbances in response to aircraft presence (Nowacek et al. 2007).

There are also some, although relatively few, oil and gas activities within the action area, the operations of which may produce noise that could impact ESA-listed cetaceans within the action area. In addition, scientific research and/or geological and geophysical seismic surveys involving

airguns may occur within the action area. These airguns generate intense low-frequency sound pressure waves capable of penetrating the seafloor and are fired repetitively at intervals of 10 to 20 seconds for extended periods (NRC 2003a). Most of the energy from the airguns is directed vertically downward, but significant sound emission also extends horizontally. Peak sound pressure levels from airguns 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, which is within the hearing range of baleen whales (Nowacek et al. 2007).

9.11 Synthesis of 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 8.1, 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.

The destruction and adverse modification analysis considers whether the action produces “a direct or indirect alteration that appreciably diminished the value of critical habitat for the conservation of a 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.

10.1 Stressors Associated with the Proposed Action

The potential stressors to ESA-listed species 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.

There is one area of critical habitat that may be affected by the action: the proposed critical habitat for Main Hawaiian Islands insular false killer whales. The potential stressors to the proposed critical habitat we expect to result from the proposed action are:

1. Pollution by oil or fuel leakage.
2. 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 *Langseth* 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, Hawaiian monk seals, or sea turtles, and will not be considered further.

10.1.2 Vessel Strike

We are not aware of a ship-strike by a seismic survey vessel. The *Langseth* 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 *Langseth* has traveled without a vessel strike. We generally expect marine mammals to move away or parallel to the *Langseth*, to avoid being struck. Furthermore, the generally slow movement of the *Langseth* 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, Hawaiian monk seals, or sea turtles and will not be considered further.

10.1.3 Disturbance from Engine Noise

We expect that the *Langseth* 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 *Langseth's* passage past a whale or sea turtle would be brief and not likely to be significant in impacting any individual's ability to feed, reproduce, or avoid predators. Brief interruptions in communication via masking are possible, but unlikely given the habits of whales 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 *Langseth* 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, Hawaiian monk seals or sea turtles and will not be considered 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 considered further.

10.2 Mitigation to Minimize or Avoid Exposure

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 3.1.4 and Section 3.1.6), 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.

Both NSF and the NMFS Permits and Conservation Division used density estimates from several sources (Barlow et al. 2009; Bradford et al. 2017b; Navy 2017). In cases where there was no density information available (e.g., North Pacific right whales, gray whales, and Western North Pacific humpback whales in the Emperor Seamounts survey), we based the exposure estimate on mean group size (Bradford et al. 2017b; Matsuoka et al. 2009; Rugh et al. 2005).

The estimated density of each marine mammal species within an area (animals/km²) is multiplied by the total ensonified areas (km²) 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. Since the tracklines in the Hawaii survey travel through deep (>1,000 m) and intermediate depth (100 to 1,000 m) waters, the radii of the ensonified area changes. The daily ensonified area for the Hawaii tracklines in deep water is 2,566.3 km². The trackline (i.e., Line 2) going through multiple depths has a daily ensonified area of 2,888.0 km². For the Hawaii survey, the total area estimated to be ensonified to the Level B harassment threshold for the proposed survey is 65,778.5 km². The Emperor Seamounts survey takes place exclusively in deep water, and its daily ensonified area is also 2,566.3 km². For the Emperor Seamounts survey, the total area estimated to be ensonified to the Level B harassment threshold is 41,702.4 km².

Upon discussions with the NMFS' Permits and Conservation Division and the NSF, we agreed to adopt the exposure numbers (Table 6 and Table 7) developed through the calculation method described above. In cases where the calculated exposure was lower than the mean group size (e.g., gray whales, North Pacific right whales, Western North Pacific humpback 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 μ Pa (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 μ Pa (rms) isopleth (2,796-m for the 36 airgun array) represents our best understanding of the threshold at which sea turtles exhibit significant behavioral responses to airgun arrays, and the 195 dB re: 1 μ Pa (rms) isopleth will serve as the exclusion radii for sea turtles (272-m for the 36 airgun array).

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., Nieuwkirk et al. 2004).

Exposures to acoustic sound sources with levels 20 dB above those producing TTS are assumed to produce PTS. An onset-TTS criterion of 175 dB re: 1 μ Pa (rms) will have corresponding onset-PTS criteria of 195 dB re: 1 μ Pa (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.

Under the ESA take is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct.” Harm is defined by regulation (50 C.F.R. §222.102) as “an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding, or sheltering.” NMFS 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.” NMFS’ interim ESA harass definition does not perfectly equate to MMPA Level A or Level B harassment, but share some similarities with both in the use of the terms “injury/injure” and a focus on a disruption of behavioral patterns.

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.

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

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. Importantly, this is a conservative approach since all forms of Level B harassment under the MMPA necessarily constitute harassment under the ESA (e.g., NMFS 2017a). As such, for marine mammals we do not distinguish between MMPA Level B harassment and ESA harassment further. However, since no exposure estimates were provided for ESA-listed sea turtles, we considered NMFS’ interim guidance on ESA harass when evaluating whether the proposed seismic survey activities are likely to harass ESA-listed sea turtle species, and if so, to estimate the number of instances of harassment of ESA-listed sea turtles that are likely to occur. As noted above, historically NMFS has considered MMPA Level

A harassment harm and/or injury under the ESA; however, no instances of MMPA Level A harassment or harm were estimated or likely to occur for ESA-listed marine mammals.

It is important to note that the best available density models used in our exposure analysis are habitat based in that they predict animal distributions based on sighting records and correlated environmental data. As such, they do not necessarily produce overall abundance estimates in line with those given in *Status of Species and Critical Habitat Likely to be Adversely Affected*, which are not spatially explicit. In many cases (e.g., fin and sperm whales), these density models predict much higher abundance estimates than those presented in Section 8.1 since they predict animal distributions well beyond areas that have been surveyed. Given this, it is not always relevant to compare exposure estimates to the abundances given in Section 8.1 since these abundance estimates were not used directly in estimating exposure. Instead, in some cases exposure estimates should be compared to abundance estimates derived from the density models used to estimate exposure.

The exposure analysis for this opinion is concerned with the number of Western North Pacific gray whale, North Pacific right whale, sei whale, fin whale, blue whale, sperm whale, and Main Hawaiian Islands Insular false killer whale, Hawaiian monk seal, as well as leatherback, Central North Pacific DPS green, North Pacific Ocean DPS loggerhead, olive ridley, and hawksbill sea turtles likely to be exposed to received levels greater than 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$ for marine mammals and 175 dB for sea turtles, which constitute the best estimate of adverse response by ESA-listed whales, Hawaiian monk seals, 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 $\mu\text{Pa}_{\text{rms}}$. 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 of Endangered Species Act-Listed Whales to Airguns

As discussed in the *Status of Species and Critical Habitat Likely to be Adversely Affected* section, there are five ESA-listed whale species that are likely to be affected by the proposed action: Western North Pacific gray whale, North Pacific right whale, sei whale, fin whale, blue whale, sperm whale, and Main Hawaiian Islands Insular false killer whale. The proposed action will take place in two disparate geographic locations in the North Pacific Ocean. As a result, different whale species may be exposed at either the Hawaii or Emperor Seamounts survey areas. There are different sources of marine mammal density data available for the Emperor Seamounts and the Hawaii survey areas. Each survey area is discussed separately below.

10.3.1.1 Whale Exposure: Hawaii Survey

Sei whales, fin whales, blue whales, sperm whales, and Main Hawaiian Islands Insular false killer whales are expected to be in the Hawaii survey area.

As discussed above, we estimated the amount of ESA-listed whales which could be exposed throughout the entire action area; in this case, that means the entire ensonified area for the seismic survey in the proposed action area. The numbers presented in the NMFS Permits and Conservation Division's take request represent the amount of take expected during the Hawaii survey.

To summarize, the estimated density of each marine mammal species within an area (animals/1,000 km²) is multiplied by the daily ensonified areas (km²) that corresponds to the MMPA Level B harassment threshold for the species. Densities for sei, fin, blue, and sperm whales came from Bradford et al. (2017a); density for Main Hawaiian Islands Insular false killer whales came from Bradford et al. (2015). The product (rounded) is the number of instances of take for each species within one day is then multiplied by the number of survey days (plus 25 percent contingency). The result is an estimate of the number of instances that marine mammals are predicted to be exposed to airgun sounds above the MMPA Level B harassment thresholds over the duration of the proposed seismic survey. Proposed and estimated takes for marine mammal species calculated by NMFS Permits and Conservation Division are in Table 6.

Table 6. Exposure estimates for Endangered Species Act-listed whales during the Hawaii survey.

Species	Estimated Density (animals/1,000 km ²)	Exposure Estimate
Sei Whale	0.16	11
Fin Whale	0.06	4
Blue Whale	0.05	5
Sperm Whale	1.86	123
Main Hawaiian Island Insular False Killer Whale	0.9	20

Multiplying the density by the total ensonified area plus contingency, we calculated that 5 Main Hawaiian Island insular false killer whales would be exposed to the proposed action. However, Main Hawaiian Islands Insular false killer whales are highly social animals, spending time in groups to forage, socialize, and nurture young (82 FR 51186). There is some variation in the mean group size (possibly due to differences in survey methods), but false killer whales are commonly sighted in groups of 10 to 20 (Baird 2009; Baird et al. 2010; Wade and Gerrodette 1993); 20 individuals is regarded as about the average group size (Oleson et al. 2010b). Since it is likely that a group of false killer whales would be encountered during the survey, it is reasonable to increase the exposure estimate from 5 individuals to 20.

Blue, fin, sei, sperm, and Main Hawaiian Islands Insular killer whales of all age classes are likely to be exposed. Whales are expected to be feeding, traveling, or migrating in the area and some females would have young-of-the-year accompanying them. These individuals could be exposed to the proposed seismic survey activities while they are transiting through the action area. We would normally assume that sex distribution is even for Blue, fin, sei, and Main Hawaiian Islands Insular killer 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.

Sperm whales are widely distributed in Hawaiian waters throughout the year (Mobley Jr. et al. 2000), and higher densities occur in deep, offshore waters (Forney et al. 2015). All sightings during surveys of the Main Hawaiian Islands in 2000 to 2012 were made in water >1000-m in depth, with most sightings in areas >3000-m deep (Baird et al. 2013a).

Blue whale calls have been recorded near Hawaii during August to April (Stafford et al. 2001). No sightings were made in the Hawaiian Islands exclusive economic zone during surveys in July to December 2002 (Barlow 2006; Barlow et al. 2004). One sighting was made in the Northwestern Hawaiian Islands during August to October 2010 (Bradford and Lyman 2013). Three additional sightings in the exclusive economic zone were made by observers on Hawaii-based longline fishing vessels during 1994 to 2009, including one in offshore waters north of Maui (Carretta et al. 2018).

Sightings of fin whales have been made in Hawaiian waters during fall and winter (Edwards et al. 2015), but fin whales are generally considered uncommon at that time (DON 2005). During spring and summer, their occurrence in Hawaii is considered rare (Edwards et al. 2015).

In Hawaii, sei whales are generally considered uncommon. However, six sightings were made during surveys in the Hawaiian Islands exclusive economic zone in July to December 2002 (Barlow 2006), including several along the north coasts of the Main Hawaiian Islands (Barlow et al. 2004). All sightings occurred in November, with one sighting reported near proposed seismic Line 3 north of Hawaii Island (Barlow et al. 2004).

Main Hawaiian Islands Insular false killer whales occur year-round in the Main Hawaiian Islands. High-use areas in Hawaii include the north half of the Island of Hawaii, the northern areas of Maui and Molokai, and southwest of Lanai (Baird et al. 2012a). These areas are considered biologically important areas (Baird et al. 2015), and proposed seismic Line 1 to the west of the Island of Hawaii traverses that area. Individuals are found up to 122-km from shore (Baird et al. 2012a).

10.3.1.2 *Whale Exposure: Emperor Seamounts Survey*

As in the Hawaii exposure estimate, the estimated density of each marine mammal species within an area (animals/1,000 km²) is multiplied by the daily ensonified areas (km²) that

corresponds to the MMPA Level B harassment threshold for the species. Densities for sei, fin, blue, and sperm whales came from the Navy (2017). Densities for gray, humpback, and North Pacific right whales were either unavailable, or the calculated density resulted in an estimate that was less than the expected mean group size. The Emperor Seamounts seismic survey would be expected to encounter and to incidentally take this species, and we believe it is likely that this species may be encountered in groups, it is reasonable to conservatively assume that one group of each of these species will be taken during the proposed seismic survey. For gray whales, North Pacific right whales, and Western North Pacific humpback whales, the exposure estimates were increased to mean group size based on Navy (2017), and Rugh et al. (2005) (gray whales). Exposure estimates for ESA-listed whales in the Emperor Seamounts survey area are listed in Table 7.

Table 7. Exposure estimates for Endangered Species Act-listed whales during the Emperor Seamounts survey.

Species	Estimated Density (animals/1,000 km ²)	Exposure Estimate
Gray Whale	N/A	2
North Pacific Right Whale	0.01	2
Sei Whale	0.29	14 (3/11)
Fin Whale	0.20	8
Blue Whale	0.13	5
Sperm Whale	2.20	90
Western North Pacific Humpback Whale	0.41	2

Three sei whales were predicted to be exposed to sound levels that would result in Level A harassment, the remaining 11 exposures are predicted to result in Level B harassment. These are the only Level A takes predicted for the proposed action. The modeled radial distances for the low frequency cetacean hearing group (i.e., sei whales) for the 36-airgun array (base configuration and generator-generator configuration) corresponding to Level A harassment thresholds were 320.2-m and 38.9-m.³

³ Because of some of the assumptions included in the methods used, isopleths produced may be overestimates to some degree, which will ultimately result in some degree of overestimate of takes by MMPA Level A harassment. However, these tools offer the best way to predict appropriate isopleths when more sophisticated three-dimensional modeling methods are not available, and NMFS continues to develop ways to quantitatively refine these tools and will qualitatively address the output where appropriate. For mobile sources, such as the proposed seismic surveys,

For reference, the Emperor Seamounts survey area is approximately between 166° to 173°E, and 43° to 47°N.

Gray whales, North Pacific right whales, sei whales, fin whales, blue whales, Western North Pacific humpback, and sperm whales, are expected to be present in the Emperor Seamounts survey area. Whales of all age classes are likely to be exposed. Given that the survey will take place in spring of 2019, 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.

Sei and fin whales are found in and around the Emperor Seamounts. Like other whale species, sei and fin whales spend the summer and fall months on higher-latitude feeding grounds. There are three major oceanic fronts in the region that serve as important feeding grounds for sei whales in summer (i.e., July) (Ishii et al. 2017; Murase et al. 2014). Fin whales are found between 150°E and 170°E from May through September, with a high density are north of 45°N (Matsuoka et al. 2009). During the time the Emperor Seamounts seismic survey would take place, we expect that these whales would be migrating to the feeding grounds in the area.

The Emperor Seamounts are in the Western North Pacific humpback whale summer feeding area (Muto et al. 2018). Observers noted a northward movement pattern between early summer (May and June), and mid-summer (July and August) (Matsuoka et al. 2009). Since the survey for the Emperor Seamounts would take place in the spring of 2019, we expect that Western North Pacific humpback whales would be migrating from the Asian wintering areas near the Philippines towards the feeding areas at that time (Muto et al. 2018). The migratory path is not well understood, but humpbacks reported moving through Ogasawara and Okinawa were later sighted in the Bering Sea, and the northward movement pattern was observed in the area surrounding the Emperor Seamounts (Matsuoka et al. 2009).

The range of the North Pacific right whale includes the U.S. West Coast to Russia, above 35°N, with rare, extralimital sightings along Baja California (Muto et al. 2018). North Pacific right whales are consistently sighted in the southeastern Bering Sea in summer months, remaining there from May through September (Munger and M. 2005; Stafford et al. 2010). Survey data over the period of 1994 to 2014 indicates that the species is distributed north of 37°N from May to September, and mostly north of 42°N in July and August. In addition, the highest number of North Pacific right whales were reported in the area from 157° to 170°E, which overlaps with the

the user spreadsheet predicts the closest distance at which a stationary animal will not incur PTS if the sound source traveled by the animal in a straight line at a constant speed.

Emperor Seamounts survey area (Matsuoka et al. 2009). In the winter, North Pacific right whales are believed to occupy higher latitudes in the northern Bering and southern Chukchi Seas (Muto et al. 2018). No calving grounds have been identified, and the migratory paths are not known. Because the Emperor Seamounts seismic survey would take place in the spring, we would expect that North Pacific right whales would be traveling northward to the feeding grounds in the southeastern Bering Sea. Since the migratory pathways are unknown, we cannot know for certain where the right whales would travel through, but given the information available about their distribution, it seems plausible that North Pacific right whales may be exposed to the proposed seismic activities while migrating northward.

Sperm whales were found throughout the western North Pacific (overlapping with the Emperor Seamounts survey area) in early summer (May through June) and late summer (July through September). There are an estimated 16,000 to 20,000 in the area between 140°E and 170°E, and 35°N to 51°N (Hakamada et al. 2009). Sperm whales breed at southern latitudes (south of 40°N) in spring (Barlow and Taylor 2005). We expect that any sperm whales exposed to the proposed seismic activities would be moving to the feeding area or already present in the feeding area.

Blue whales in the region follow a similar movement pattern to that of other whales—a main distribution from 35°N to 40°N in May and June, and then north of 40°N in July and August (Matsuoka et al. 2009). In this study, the majority of the survey effort took place from May to September. There was some limited survey effort off the coast of Japan in April, but none in the area near the Emperor Seamounts.

The western gray whale population feeds in the Okhotsk Sea along the northeast coast of Sakhalin Island (Weller et al. 2002; Weller et al. 2008; Weller et al. 1999), eastern Kamchatka, and the northern Okhotsk Sea in the summer and autumn (Vladimirov et al. 2008). In the western North Pacific, gray whales migrate along the coast of Japan (Weller et al. 2008), and records have been reported there from November through August, with the majority for March through May (Weller and Brownell Jr. 2012). Although the offshore limit of this route is not well documented, gray whales are known to prefer nearshore coastal waters. However, some exchange between populations in the eastern and western North Pacific has been reported (Mate et al. 2015; Weller and Brownell Jr. 2012); thus, migration routes could include pelagic waters of the Pacific Ocean, including the proposed Emperor Seamounts survey area.

Humpbacks were reported within the proposed action area in May, July, and August (Matsuoka et al. 2009). Based on the timing of the action, it is likely that humpback whales from the Western North Pacific DPS would be migrating north through the action area to the feeding grounds, and thus be exposed to the action.

10.3.2 Exposure of Endangered Species Act-Listed Pinnipeds to Airguns

The Hawaiian monk seal is the only ESA-listed pinniped we expect to be exposed to the proposed action. Because it is solely found in Hawaii, we expect it to be exposed to the proposed

action in the Hawaii survey area, and not during seismic activities around the Emperor Seamounts.

In their technical report, Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area October 2017, the U.S. Navy calculated density of Hawaiian monk seal for three areas: the Main Hawaiian Islands in waters less than 200-m, the Northwest Hawaiian Islands in waters less than 200-m, and waters 200-m deep to the Hawaiian exclusive economic zone boundary. The 200-m isobath was selected as a boundary because of information related to Hawaiian monk seal foraging behavior that came out of the final rule for designated critical habitat. Ninety-eight percent of recorded dives were within the 200-m isobath in the Main Hawaiian Islands (NMFS Critical Habitat Biological Report 2014); this depth boundary was considered sufficient for foraging habitat for adults and juveniles. The area around the Main Hawaiian Islands to the 200-m isobath was estimated to be 6,630 km² (6,142 km² in the Northwest Hawaiian Islands). The area from the 200-m isobath to the Hawaiian exclusive economic zone is estimated to be 2,461,994 km². The U.S. Navy also assumed that 90 percent of the population would occur inside the 200-m isobath. The U.S. Navy used Wilson et al. 2017 to estimate the amount of time monk seals would spend in the water (68 percent) versus on land (32 percent). The U.S. Navy also used a population estimate from an earlier stock assessment report (1,112 seals) (Carretta et al. 2016); this estimate was later revised to 1,272 seals (147 on the Main Hawaiian Islands; 1,125 in the Northwest Hawaiian Islands).

The U.S. Navy used the following calculation to estimate density:

$$[(\text{number of seals} * \text{percent of the population in or out of the 200-m}) / \text{200-m area}] * \text{In-water factor}$$

By applying the U.S. Navy's methodology using updated population estimates from the 2017 Stock Assessment Report (Carretta et al. 2017), we estimated Hawaiian monk seal density. We expect that three Hawaiian monk seals may be exposed to the proposed action.

10.3.3 Exposure of Endangered Species Act-Listed Sea Turtles to Airguns

As discussed in the *Status of Species and Critical Habitat Likely to be Adversely Affected* section, there are five ESA-listed sea turtle species that are likely to be affected by the proposed action: Central North Pacific DPS of green, hawksbill, leatherback, North Pacific Ocean DPS of loggerhead, and olive ridley turtles (range wide).

The NSF calculated estimated distances for the 175 dB re: 1 µPa (rms) sound levels generated by the 36 airguns (6,600 in³) towed at 12-m in deep waters (> 1,000-m deep) and intermediate depth waters (100 to 1,000-m deep). When the 36-airgun array is towed in deep water, the predicted established distance at received levels of 175 dB re: 1 µPa (rms) is 1,864-m. When the 36-airgun array is towed in intermediate depth water, the predicted established distance at received levels of 175 dB re: 1 µPa (rms) is 2,796-m. 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.

The proposed action area contains two distinct survey areas where the seismic airguns will be operating, thus potentially exposing ESA-listed sea turtles to the stressors associated with airguns. There are different sources of sea turtle density information available for the Emperor Seamounts and the Hawaii survey areas. In addition, the species of sea turtle that we would expect to be present would vary by survey area. Each survey area is discussed separately below.

10.3.3.1 *Sea Turtle Exposure: Hawaii Survey*

The 175 dB re: 1 μ Pa (rms) harassment ensonified area for the entire Hawaii action area was determined by calculating the radius, diameter, and area surrounding the airgun array, which was then multiplied by the trackline distances (3,403 km in deep water, and 52 km in intermediate depth water) for the Hawaii seismic survey (Table 8).

Table 8. Ensonified areas, estimated densities, and take estimates for the Pacific sea turtle guild of Endangered Species Act-listed sea turtles in the proposed Hawaii survey area.

	Deep Water (> 1,000 meter)	Intermediate Water (100 to 1,000 meters)
175 dB Area (km²)	10.92	24.56
Trackline Distance (km)	3,403	52
Ensonified Area (km²)	37,160.76	1,277.12
Pacific Sea Turtle Guild Density (animals/km²)	0.0043	0.0043
Sea Turtles Exposed (n)	160	6

Density estimates for the action area were derived from data in the Navy's technical report *U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area* (Navy 2017), which relied on data sets obtained by U.S. Navy biologists during monitoring activities (Baird et al. 2013b; Smultea et al. 2008).

Due to a lack of data on occurrence and to account for the known occurrence of multiple sea turtle species, the green, hawksbill, leatherback, loggerhead, and olive ridley turtle species were all combined and analyzed by the U.S. Navy under the Pacific sea turtle guild for spring, summer, fall, and winter seasons in the Hawaii Range Complex to create an estimate of sea turtle densities. For this consultation, we used the Pacific sea turtle guild density for the location beyond the 100-m isobaths (i.e., 0.0043 animals per km²). The U.S. Navy reduced the mean density value by two orders of magnitude for the area beyond the 100 m (328.1 ft) isobaths when compared to conservative estimate density values for coastline and shallow water habitats that are preferred by Central North Pacific DPS of green turtles (Navy 2017). By applying this

density to the total ensonified areas, we calculated that 166 sea turtles would be exposed to the Hawaii seismic survey (160 turtles in deep water, and 6 turtles in intermediate water) (Table 8).

Because no offshore abundance or density is available for sea turtle species, the NMFS Pacific Islands Fisheries Science Center recommended that the U.S. Navy obtain and use data from reported longline fishery interactions with sea turtles to estimate offshore relative abundance for these species. Based on the per-species proportions of sea turtle interactions with longline fishing activities in the Hawaii Range Complex from 2014 through 2016, the U.S. Navy derived the offshore relative abundance breakdown as four percent for Central North Pacific DPS of green turtles, one percent for hawksbill turtles, 39 percent for leatherback turtles, 37 percent for loggerhead turtles, and 19 percent for olive ridley turtles. The U.S. Navy used a one percent for hawksbill turtles in the offshore breakdown of the Pacific sea turtle guild to be conservative to the species even though a fishery interaction with that species has never been reported. By applying these relative abundance percentages to the calculated number of sea turtle exposures, we estimate that 7 green, 1 hawksbill, 65 leatherback, 61 loggerhead, and 32 olive ridley sea turtles would be exposed to the proposed seismic activities in the Hawaii survey area.

We are relying on the extent of the ensonified area corresponding to injurious or behavioral thresholds as a surrogate to estimate sea turtle exposure. The 175 dB re: 1 μ Pa (rms) exclusion zone (10.92 km² or 24.56 km²) represents the distance to which sound levels will extend from the sound source and be in the hearing range of sea turtles. If a sea turtle were within this exclusion zone during operations of the airgun array, it would be exposed to the stressor (i.e., the sound field produced by the airguns) and be taken by harassment.

The population status of green turtles in Hawaii has been improving, with larger number of green turtles recorded near the Main Hawaiian Islands with some areas possible approaching carrying capacity (Chaloupka et al. 2009a; Chaloupka and Balazs 2007). Green turtles are the most abundant sea turtle within nearshore waters of Hawaii, but are less common further offshore of the Hawaiian Islands where they occur in much lower numbers and densities.

A small nesting population of hawksbill turtles has been documented in the Hawaiian Islands, but it is not known whether the population is increasing, decreasing, or stable (NMFS 2013b). Hawksbill turtle hatchlings generally prefer open ocean environments and later move to coastal habitats and nearshore foraging ground during their juvenile phase around the Hawaiian Islands.

Leatherback turtles occur in offshore areas surrounding the Hawaiian Islands beyond the 100 m and are rare shoreward. They are regularly sighted in offshore waters surrounding the Hawaiian Islands generally beyond the 1,158.2 m (3,800 feet) depth contour and around seamounts north of the Northwestern Hawaiian Islands. Bailey et al. (2012b) used tracking data to predict and identify areas of relative high use for leatherback turtles in the Pacific Ocean, which varied seasonally and correlated with likely migration routes. From April through June, areas of higher use were centered on the Hawaiian Islands with a slightly greater intensity of use northeast of the islands.

Loggerhead turtles have the highest densities in the North Pacific Transition Zone just north of Hawaii (Polovina et al. 2000). They may be present in the action area as they have transoceanic migrations between Japan and Baja California, Mexico.

Olive ridley turtles have been documented nesting in the Hawaiian Islands on rare instances (e.g., Hawaii, Maui, and Oahu). Juveniles, sub-adults, and adult sea turtles are present in the action area and these life stages could be exposed to the proposed action.

Green, hawksbill, and olive ridley turtles all have been documented nesting in the Hawaiian Islands and hatchlings for these species could be exposed to the proposed action. Neither leatherback nor loggerhead turtles are known to nest in Hawaii.

10.3.3.2 *Sea Turtle Exposure: Emperor Seamounts*

The Emperor Seamounts survey area is approximately between 166° to 173°E, and 43° to 47°N, in waters more than 1,500 m deep, and over 1,000 km from land. Since the Emperor Seamounts are in a different environment than the Hawaii survey, we expect different species of sea turtles to be exposed. Hawksbill sea turtles are circumtropical, and the survey area is north of where we expect them to be found. The northern boundary of the Central West Pacific DPS green sea turtles is at 41°N, south of the Emperor Seamounts survey area. Therefore, we do not expect either green or hawksbill sea turtles to be exposed in the Emperor Seamounts survey area. We expect that North Pacific DPS loggerhead, olive ridley, and leatherback sea turtles could be exposed to the proposed seismic activities in the Emperor Seamounts survey area.

Unlike the Hawaii survey, there is no available sea turtle density information, and we were not able to calculate the number of sea turtles potentially exposed during the Emperor Seamounts survey. Further, there is not much information on sea turtle distribution or occurrence throughout the Emperor Seamounts area. What little information that is available focuses on the Kuroshio Current, a warm, north-flowing ocean current part of the North Pacific Ocean gyre. The Kuroshio Extension (part of the current system) meanders along the 35°N latitude from the east coast of Japan. The Kuroshio Bifurcation Current extends off of the Kuroshio Extension, moving northeast towards 40°N (Figure 21) (Itoh and Yasuda 2010). The eddies cause upwellings that make the area productive, rich in nutrients and chlorophyll *a*, and thus attractive to marine life.

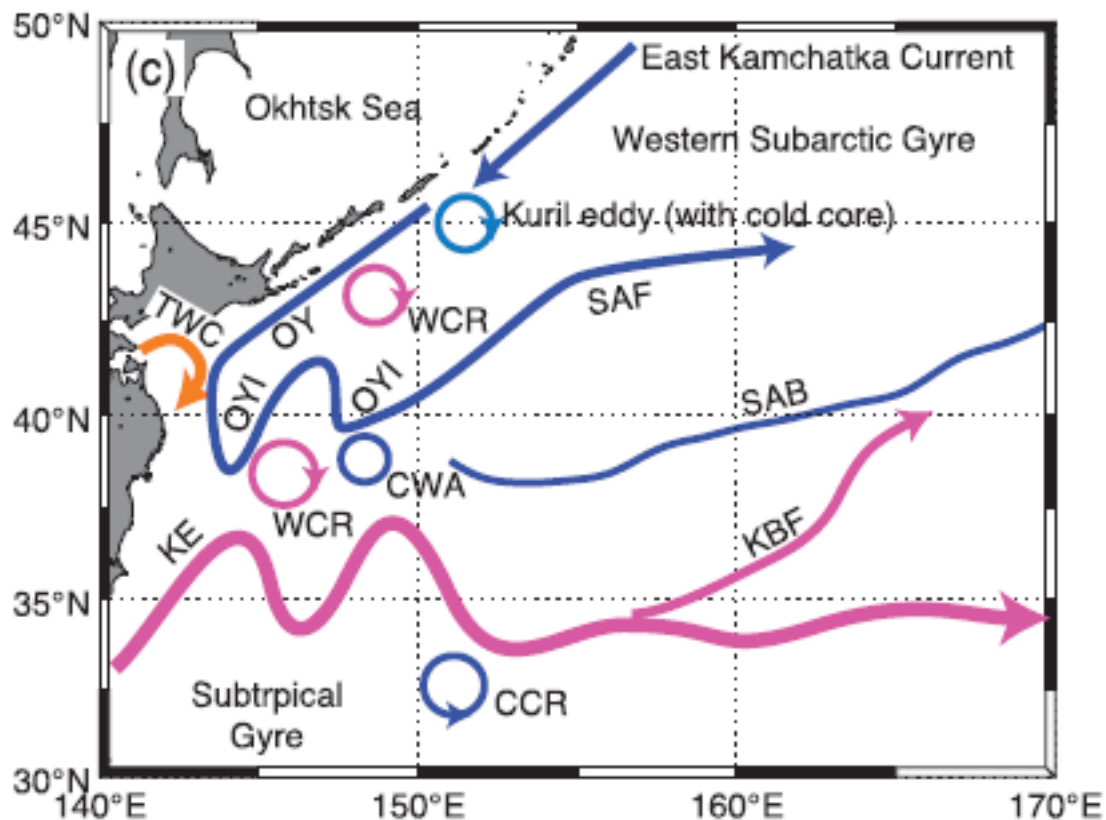


Figure 21. Map of the Kuroshio Current and associated currents in the North Pacific Ocean, near the Emperor Seamounts survey area. From Itoh and Yasuda 2010.

Leatherback sea turtles that were tagged in Papua Barat, Indonesia were tracked through the North Pacific Ocean and into the Kuroshio Extension Current and within the action area (Bailey et al. 2012a; Benson et al. 2011a). We expect that adult leatherbacks that may be exposed to the proposed survey would be migrating through to or from the feeding areas off the U.S. Pacific Coast. Olive ridley and loggerhead sea turtles have also been observed associating with the Kuroshio Extension Bifurcation Region, and have been caught in longlines in the region (Polovina et al. 2006; Polovina et al. 2003). It should be pointed out that the Kuroshio Current and its associated currents are largely south of the Emperor Seamounts survey area (44°N to 47°N latitude and 166°E to 173°E longitude). Although we do not have information on sea turtle density specific to the Emperor Seamounts area, we know that sea turtles are present in the region, and that there is a likelihood of exposure to the proposed seismic activities.

10.3.4 Exposure of Main Hawaiian Islands Insular False Killer Whale Critical Habitat to Airguns

On July 24, 2018, NMFS designated critical habitat for the Main Hawaiian Islands Insular false killer whale, around the Main Hawaiian Islands, from the 45-meter to the 3,200-meter depth

contour. There are two survey lines that go through the proposed critical habitat—the north and south Lines 1 and 2 are between the islands of Hawaii and Maui, and to the west of Oahu. As noted earlier, Lines 1 and 2 would be surveyed twice, once for seismic refraction data, and once for multi-channel seismic reflection profiling. The *Langseth* would travel at a speed of 4.1 knots (7.6 km/hour).

The critical habitat has one physical and biological feature with four characteristics, two of which may be affected by being exposed to the seismic activities around Hawaii. These features are:

- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth.
- Sound levels that would not significantly impair false killer whales' use or occupancy.

The sound created by the airguns could match the description of sound levels that could affect the value of the habitat for false killer whales. In addition, the noise from the airguns may affect the quantity or availability of prey by disturbing or harming prey species of the false killer whale.

In the final rule, NMFS describes how sound levels are an important attribute of the island-associated habitat that is essential to the Main Hawaiian Islands Insular false killer whales' conservation. The rule states that it is important to consider “how chronic and persistent noise sources may alter the value of that habitat,” and that the “mere presence of noise, or even noise which might cause harassment of the species, does not necessarily result in adverse modification.”

To evaluate the effects of the proposed action, we are considering the degree to which the noise may impede the Main Hawaiian Islands Insular false killer whales' ability to use the habitat for foraging, navigating, and communicating, or whether the noise source may deter the population from using the habitat the entirely.

According to data provided by the NSF, the proposed seismic activities for Lines 1 and 2 around the Main Hawaiian Islands would last for about 58 hours total (Table 9). Part of Line 1 would be in the national security excluded area between the islands of Hawaii and Maui. While we think it is likely that any exposed false killer whales would avoid the action area during the survey, we believe this disturbance would be temporary, and that false killer whales would return to normal behavior and habitat occupancy; see discussion in the Response Analysis (Section 10.3.5.1) for more details.

Table 9. Length and duration of Lines 1 and 2 in designated critical habitat for Main Hawaiian Islands Insular false killer whales.

	Line 1	Line 2
Location	Between Hawaii and Maui	West of Oahu
Distance (km)	135.3	86.8

	Line 1	Line 2
Ship Speed (km/hour)	7.6	7.6
Duration (hours) Single Pass	17.8	11.4
Duration (hours) Both Passes	35.6	22.8

The proposed seismic activities in false killer whale critical habitat would be concluded in less than three days. NSF is not planning to return to the Main Hawaiian Islands to conduct another seismic survey in the near future. Because of this, we do not believe that the proposed action qualifies as chronic or persistent.

False killer whales eat fish and squid (see (Oleson et al. 2010a) for review). In its draft Environmental Assessment, the NSF discussed the effects of the proposed seismic activities on marine fishes and invertebrates, including a discussion on the sub-lethal effects of seismic activities on Main Hawaiian Islands Insular false killer whale prey species such as cephalopods and squid. Based on the information presented in the draft Environmental Assessment, there is no specific evidence that these particular fish prey for false killer whales would be adversely affected by the proposed action. In general, we expect that fish species would be disturbed or displaced temporarily by the proposed seismic activities; see discussion in the Response Analysis (Section 10.3.5.1) for more details. Solé et al. (2013) found that cephalopod species exposed to frequencies between 315 and 400 Hz and levels between 139 to 141 re 1 microPa² experienced loss of muscle tone, stressed behavior, startle behavior, and damage to the statocyst, the organ responsible for equilibrium and movement. Squid (*Sepioteuthis australis*) exhibited stressed behavior and changed swimming patterns at sound exposure levels of greater than 147 to 151 dB re 1 microPa² · s (Fewtrell and McCauley 2012). Assuming that fish and squid prey species present in the action area react the same as did the species in these studies, we expect that Main Hawaiian Islands Insular false killer whale prey would exhibit similar responses.

The short duration of the potential exposure, and the expected minor effects to prey species, lead us to conclude that the Main Hawaiian Islands Insular false killer whale critical habitat would not be adversely affected by the proposed action. We expect that the effects would be insignificant, and would not affect the conservation value of the critical habitat.

10.3.5 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.

10.3.5.1 *Potential responses of ESA-listed marine mammals to acoustic sources*

ESA-listed 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 TTS results in a temporary hearing change (Finneran 2013), and can last minutes to days. Full recovery is expected. However, a study on mice has shown that although full hearing can be regained from TTS (i.e., the sensory cells actually receiving sound are normal), damage can still occur to nerves of the cochlear nerve leading to delayed but permanent hearing damage (Kujawa and Liberman 2009). At higher received levels, particularly in frequency ranges where animals are more sensitive, PTS can occur, meaning lost auditory sensitivity is unrecoverable. 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).

For TTS, full recovery of the hearing loss (to the pre-exposure threshold) has been determined from studies of marine mammals, and this recovery occurs within minutes to hours for the small amounts of TTS that have been experimentally induced (Finneran et al. 2005; Finneran and Schlundt 2010; Nachtigall et al. 2004). The recovery time is related to the exposure duration, sound exposure level, and the magnitude of the threshold shift, with larger threshold shifts and longer exposure durations requiring longer recovery times (Finneran et al. 2005; Finneran and Schlundt 2010; Mooney et al. 2009a; Mooney et al. 2009b). For an animal to experience a large threshold shift, it would have to approach close to the sonar source or remain near the sound source for an extended period. We would not expect this to be the case due to the mitigation and

monitoring measures implemented by the NSF and Permits and Conservation Division, and that both the animal and vessel would be moving (most likely not in the same direction).

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., ESA-listed sei, fin, blue, North Pacific right, gray, and Western North Pacific humpback whales) have an estimated functional hearing frequency range of 7 Hz to 35 kHz. Sperm whales and Main Hawaiian Islands Insular false killer whales are mid-frequency cetaceans, with an estimated functional hearing frequency range of 150 Hz to 160 kHz. For pinnipeds in water, data are limited to measurements of TTS in harbor seals (*Phoca vitulina*), an elephant seal (*Mirounga angustirostris*), and California sea lions (*Zalophus californianus*) (Kastak et al. 199, 2005; Kastelein et al. 2012 b). Phocid seals, like Hawaiian monk seals, have an estimated functional hearing frequency range of 50 Hz to 86 kHz (Table 10).

Table 10. 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, <i>Lagenorhynchus cruciger</i> , and <i>Lagenorhynchus australis</i>)	275 Hz to 160 kHz
Phocids Underwater (Hawaiian monk seals)	50 Hz to 86 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 $\mu\text{Pa}_{\text{rms}}$ in order to produce a low-level TTS from a single pulse (Southall et al. 2007b). 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. 2007b). In terms of exposure to the *Langseth's* 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 $\mu\text{Pa}_{\text{rms}}$, PTS could occur. A marine mammal would have to be within

100 -m of the *Langseth's* air gun array to be within the 190 dB re 1 $\mu\text{Pa}_{\text{rms}}$ 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 $\mu\text{Pa}^2\text{s}$.

Overall, we do not expect TTS or PTS to occur to any ESA-listed whale or Hawaiian monk seal 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 $\mu\text{Pa}_{\text{rms}}$ 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.

ESA-listed 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 *Langseth* 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 *Langseth's* 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 detectable 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 masking.

ESA-listed 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. 2004; Richardson et al. 1986; Smultea et al. 2004; Tyack et al. 2003). However, humpback whale males increasingly stopped vocal displays on Angolan breeding grounds as received seismic 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 μ Pa. 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 μ Pa_{p-p} (Madsen et al. 2002; McCall Howard 1999). Some exposed individuals may cease calling in response to the *Langseth's* air guns. If individuals ceased calling in response to the *Langseth's* 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 μ Pa_{rms} as the received sound level to cause behavioral responses other than vocalization changes (Richardson et al. 1995e). 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. 1995e; 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 μ Pa_{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 μ Pa_{rms}) (Harris et al. 2007; Ljungblad et al. 1988; Miller et al. 1999; Miller et al. 2005; Richardson et al. 1995e; 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 μ Pa (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 μ Pa (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 μ Pa_{rms} (Bain and Williams 2006; Gailey et al. 2007; Johnson et al. 2007b; Malme and Miles 1985; Malme et al. 1984; Malme et al. 1986a; 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 μ Pa and

slight behavioral changes at 140 to 160 dB re 1 $\mu\text{Pa}_{\text{rms}}$ (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 $\mu\text{Pa}_{\text{rms}}$ (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 $\mu\text{Pa}_{\text{p-p}}$, 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. 1995e). 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 μ Pa lower at 1 kHz and 60 dB re 1 μ Pa 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).

Similar to other marine mammal species, behavioral responses of pinnipeds can range from a mild orienting response, or a shifting of attention, to flight and panic. They may react in a number of ways depending on their experience with the sound source and what activity they are engaged in at the time of the exposure. For example, different responses displayed by captive and wild phocid seals to sound judged to be ‘unpleasant’ have been reported; where captive seals habituated (did not avoid the sound), and wild seals showed avoidance behavior (Götz and Janik 2011). Captive seals received food (reinforcement) during sound playback, while wild seals were exposed opportunistically. These results indicate that motivational state (e.g., reinforcement via food acquisition) can be a factor in whether or not an animal habituates to novel or unpleasant sounds. Captive studies with other pinnipeds have shown a reduction in dive times when presented with qualitatively ‘unpleasant’ sounds. These studies indicated that the subjective interpretation of the pleasantness of a sound, minus the more commonly studied factors of received sound level and sounds associated with biological significance, can affect diving behavior (Götz and Janik 2011). More recently, a controlled-exposure study was conducted with U.S. Navy California sea lions at the Navy Marine Mammal Program facility specifically to study behavioral reactions (Houser et al. 2013). Animals were trained to swim across a pen, touch a panel, and return to the starting location. During transit, a simulated mid-frequency sonar signal was played. Behavioral reactions included increased respiration rates, prolonged submergence, and refusal to participate, among others. Younger animals were more likely to respond than older animals, while some sea lions did not respond consistently at any level.

Kvadsheim et al. (2010) found that captive hooded seals (*Cystophora cristata*) reacted to 1 to 7 kHz sonar signals by moving to the areas of least sound pressure level, at levels between 160 and 170 dB re: 1 μ Pa. Finneran et al. (2003) found that trained captive sea lions showed avoidance behavior in response to impulsive sounds at levels above 165 to 170 dB (rms). These studies are in contrast to the results of Costa et al (2003) which found that free-ranging elephant seals showed no change in diving behavior when exposed to very low frequency sounds (55 to 95 Hz) at levels up to 137 dB (though the received levels in this study were much lower) (Costa et al. 2003). Similar to behavioral responses of mysticetes and odontocetes, potential behavioral responses of pinnipeds to the proposed seismic activities are not expected to impact the fitness of any individual animals as the responses are not likely to adversely affect the ability of the animals to forage, detect predators, select a mate, or reproduce successfully. As noted in (Southall et al. 2007a), substantive behavioral reactions to noise exposure (such as disruption of critical life functions, displacement, or avoidance of important habitat) are considered more

likely to be significant if they last more than 24 hours, or recur on subsequent days. Behavioral reactions are not expected to last more than 24 hours or recur on subsequent days such that an animal's fitness could be impacted. That we do not expect fitness consequences is further supported by Navy monitoring of Navy-wide activities since 2006 which has documented hundreds of thousands of marine mammals on training and testing range complexes and there are only two instances of overt behavioral change that have been observed and there have been no demonstrable instances of injury to marine mammals as a result of non-impulsive acoustic sources such as low frequency active sonar. Because we do not expect any fitness consequences from any individual animals to result from instances of behavioral response, we do not expect any population level effects from these behavioral responses.

Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources proposed for use. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. Monitoring work in the Alaskan Beaufort Sea during 1996 to 2001 provided considerable information regarding the behavior of Arctic ice seals exposed to seismic pulses (Harris et al. 2001; Moulton and Lawson 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes of 560 to 1,500 in³. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal (*Phoca hispida*) sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, approximately 100 m (328 feet) to a few hundreds of meters, and many seals remained within 100 to 200 m (328 to 656 feet) of the trackline as the operating airgun array passed by the animals. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Jefferson and Curry 1994; Mate and Harvey 1987; Richardson et al. 1995a). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson et al. 1998).

Elephant seals are unlikely to be affected by short-term variations in prey availability (Costa 1993), as cited in New et al. (2014). We expect the Hawaiian monk seals considered in this opinion to be similarly unaffected. We have no information to suggest animals eliciting a behavioral response (e.g., temporary disruption of feeding) from exposure to the proposed seismic activities would be unable to compensate for this temporary disruption in feeding activity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding later.

For whales or Hawaiian monk seals 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 and Hawaiian monk seals 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 *Langseth's* presence. We expect breeding may be temporarily disrupted if avoidance or displacement occurs, but we do not expect the loss of any breeding opportunities. Individuals engaged in travel or migration would continue with these activities, although potentially with a deflection of a few kilometers from the route they would otherwise pursue.

ESA-listed marine mammals and physical or physiological effects. Individual whales or Hawaiian monk seals exposed to air guns (as well as other sound sources) could experience effects not readily observable, such as stress, which 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; Mancina 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; Herraes 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 $\mu\text{Pa} \cdot \text{m}_{\text{p-p}}$) 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. 2012b). 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.

ESA-listed 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 surveys. 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 ESA-listed marine mammal prey. Seismic surveys may also have indirect, adverse effects on prey availability through lethal or sub-lethal damage, stress responses, or alterations in their behavior or distribution. Studies described herein provide extensive support for this, which is the basis for later discussion on implications for ESA-listed whales and Hawaiian monk seals. 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 ESA-listed species 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 μ Pa) 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 μ Pa²·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 μ Pa_{p-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 μ Pa (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 μ Pa_{0-p} and alarm responses at greater than 177 dB re 1 μ Pa_{0-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 μ Pa_{0-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 μ Pa_{0-p} air gun sound, but habituated to the sound after 1 hour and returned to normal depth (sound environments of 185 to 192 dB re 1 μ Pa) 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 μ Pa_{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 μPa_{0-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 -m 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 μPa_{p-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 μPa_{0-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 Løkkeborg 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 μPa_{0-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 study 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 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.

ESA-listed whale 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.⁴ 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 μ Pa 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 μ Pa. 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. 1995e).

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. 2006a; 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. 1995e; Silber 1986a; Thompson et al. 1986a; Tyack 1983a; Tyack and Whitehead 1983; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997; Weir et al. 2007; Winn et al. 1970a). The response of a blue whale to 3.5 kHz sonar supports this species ability to hear this signal as well (Goldbogen 2013). Maybaum (1990a; 1993) observed that Hawaiian humpbacks moved away and/or increased swimming speed upon exposure to 3.1

⁴ <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 *Langseth*, 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 *Langseth*'s 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 the Lamont-Doherty Earth Observatory 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 ESA-listed 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.

10.3.5.2 *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 (1990) found loggerhead sea turtles exhibited an avoidance

reaction at an estimated sound level of 175 to 176 dB re 1 $\mu\text{Pa}_{\text{rms}}$ (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 1994b; Lenhardt et al. 1983). However, loggerheads resting at the ocean surface were observed to startle and dive as active seismic source approached them (DeRuiter 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 $\mu\text{Pa}^2\text{-s}$ (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 μ Pa 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 μ Pa. At 175 dB re 1 μ Pa, we anticipate some change in swimming patterns and a stress response of exposed individuals. Some turtles may approach the active seismic array to closer proximity, but we expect them to eventually turn away. We expect temporary displacement of exposed individuals from some portions of the action area while the *Langseth* transects through.

Sea turtles and stress. Direct evidence of seismic sound causing stress is lacking in sea turtles. However, we expect sea turtles to generally avoid high-intensity exposure to 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 μ Pa). 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 μ Pa, 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 10 blue, 12 fin, 25 sei, 213 sperm, 2 gray, 2 North Pacific right, 2 Western North Pacific DPS humpback, and 20 Main Hawaiian Islands Insular false killer whales, and 3 Hawaiian monk seals within the Hawaii and Emperor Seamounts areas during air gun operations to be exposed to noise from the air guns during the seismic survey (Table 11). We expect that any leatherback, Central North Pacific DPS green, North Pacific Ocean DPS loggerhead, olive ridley or hawksbill sea turtles within the ensonified areas during air gun operations to be exposed to the air guns during the seismic survey.

Table 11. Total Exposure Estimates for ESA-listed Marine Mammals for the NSF North Pacific Seismic Survey and the Permits and Conservation Division's Incidental Harassment Authorization.

Species	Hawaii	Emperor Seamounts	Total Exposures
Blue Whale	5	5	10
Fin Whale	4	8	12
Sei Whale	11	14	25
Sperm Whale	123	90	213
Main Hawaiian Islands Insular False Killer Whale	20	0	20
Gray Whale	0	2	2
North Pacific Right Whale	0	2	2
Western North Pacific Humpback Whale	0	2	2
Hawaiian Monk Seal	3	0	3

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, gray, North Pacific right, Western North Pacific DPS humpback, or Main Hawaiian Islands Insular false killer whales, Hawaiian monk seals, or leatherback, Central North Pacific DPS green, North Pacific Ocean DPS loggerhead, olive ridley or hawksbill 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* (Section 12) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the *Status of the Species and Critical Habitat* (Section 8.1).

The following discussions separately summarize the probable risks the proposed action poses to threatened and endangered species and critical habitat that are likely to be exposed. These summaries integrate 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 North Pacific Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

Current estimates indicate approximately 5,000 to 12,000 blue whales globally, and about 2,500 in the North Pacific (IWC 2007b). The eastern North Pacific stock has a population estimate of $N = 1,647$ ($N_{\min} = 1,551$) (Calambokidis and Barlow 2013; Muto et al. 2018). Gerrodette (1993) estimated 1,400 blue whales in the eastern tropical Pacific; while Bradford and Lyman (2013) estimated 81 blue whales in the Hawaiian exclusive economic zone. No population trend information is available.

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 Whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Identify and protect 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.

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 North Pacific Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

Fin whales in the Northeast Pacific (near the western Aleutian islands and in the Bering Sea) have limited abundance data available, but the minimum population estimate is 2,254, which is likely an underestimate (Muto et al. 2018). Fin whales are considered rare in Hawaii. Bradford et al. (2017a) estimated 154 fin whales in Hawaiian waters. There is no population trend information available for fin whales in Hawaii or in the North Pacific (Carretta et al. 2018).

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 North Pacific Ocean is expected because of the NSF's seismic research activities and the Permits and Conservation Division's issuance of an IHA.

Sei whale abundance in the Eastern North Pacific is estimated at 519 individuals ($N_{\min}=374$) (Barlow 2016). Summertime abundance estimates over a broader range in the central and eastern

North Pacific (170°E and 135°W, north of 40°N) give an estimate of 29,632 (CV=0.242) (Hakamada et al. 2017). Bradford et al. (2017a) estimated that there were 391 individuals (CV=0.9) (N_{\min} =204) in the Hawaii stock. However, this survey took place in the summer and fall, when sei whales are expected to be at higher latitudes on feeding grounds, so this is possibly an underestimate. Population growth rates for sei whales in the North Pacific or Hawaii 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 is no minimum abundance estimate available for sperm whales in the North Pacific. There are estimates for various portions of the population however, including one for the western North Pacific (102,112 individuals), which is likely positively biased (Kato 1998), and between 129 and 135 individuals in the Gulf of Alaska (Rone et al. 2017). Another survey taking place in the western North Pacific (35°N to 51°N and 140°E to 170°E) estimated 15,929 sperm whales in the area in May and June, and 20,292 in the area in July and September (Hakamada et al. 2009). The minimum population estimate for the Hawaii stock of sperm whales is 3,478 individuals (Carretta et al. 2018). There is insufficient data to evaluate trends in abundance and growth rates of sperm whales in the North Pacific or Hawaii 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 False Killer Whale Main Hawaiian Island Insular Distinct Population Segment

No reduction in the distribution of false killer whale Main Hawaiian Island Insular DPS is expected because of the NFS's seismic research activities and the Permits, and Conservation Division's issuance of an IHA.

The false killer whale Main Hawaiian Islands insular DPS is estimated at between 162 and 151, with a minimum population estimate at 92. The trends in population growth for the DPS 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 false killer whale Main Hawaiian Islands insular DPS whales because of the proposed research activities, a reduction in the species' likelihood of survival is not expected.

There is no Recovery Plan for Main Hawaiian Islands Insular false killer whales, so we cannot evaluate whether or not the proposed actions would impede any recovery objectives. However, because we do not expect the proposed actions to cause any reductions in the species' distribution, reproduction, or population. 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 false killer whales in the wild.

11.6 False Killer Whale Main Hawaiian Islands Insular DPS Proposed Critical Habitat

Because of the relatively short duration of the proposed action in the proposed critical habitat for Main Hawaiian Islands Insular false killer whales, we do not expect the seismic activities to appreciably diminish the conservation value of the proposed critical habitat. We expect the effects of the proposed action to be minimal and temporary, and that false killer whale occupancy of the area, and the quantity and quality of prey will not be significantly affected. In conclusion, we believe the effects associated with the proposed actions are not expected to cause a reduction in the value of the physical and biological features of the proposed critical habitat.

11.7 Western North Pacific Gray Whale

No reduction in the distribution of Western North Pacific gray whales from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

The minimum population estimate for the Western North Pacific stock is 135 individual gray whales on the summer feeding ground off Sakhalin Island. The current best growth rate estimate for the Western North Pacific gray whale stock is 3.3 percent annually.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of Western North Pacific gray whales as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

There is currently no Recovery Plan for the Western North Pacific gray whale. Because no mortalities or effects on the distribution of Western North Pacific gray whale populations are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for Western North Pacific gray whale. 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 Western North Pacific gray whales in the wild.

11.8 North Pacific Right Whale

No reduction in the distribution of North Pacific right whales from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

North Pacific right whale abundance likely numbers fewer than 1,000 individuals, with several lines of evidence indicate a total population size of less than 100. There is currently no information on the population trend of North Pacific right whales.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of North Pacific right whales as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

The 2013 Final Recovery Plan for the North Pacific Right Whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

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

Because no mortalities or effects on the distribution of the North Pacific right whale population are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for North Pacific right 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 North Pacific right whales in the wild.

11.9 Humpback Whale Western North Pacific Distinct Population Segment

No reduction in the distribution of Western North Pacific DPS humpback whales from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

The current abundance of the Western North Pacific DPS is 1,059 (81 FR 62259). A population growth rate is currently unavailable for the Western North Pacific humpback whale DPS.

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of Western North Pacific DPS humpback whales as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

The 1991 Final Recovery Plan for the Humpback Whale lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed actions:

- Maintain and enhance habitats used by humpback whales currently or historically.
- Identify and reduce direct human-related injury and mortality.

Because no mortalities or effects on the distribution of Western North Pacific DPS humpback whales are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for Western North Pacific DPS humpback 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 Western North Pacific DPS humpback whales in the wild.

11.10 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 *Langseth's* presence. We expect

breeding may be temporarily disrupted if avoidance or displacement occurs, but we do not expect the loss of any breeding opportunities. Individuals engaged in travel or migration would continue with these activities, although potentially with a deflection of a few kilometers from the route they would otherwise pursue.

11.11 Hawaiian Monk Seal

No reduction in the distribution of Hawaiian monk seals from the Main Hawaiian Islands is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

The latest published estimate of the total population of Hawaiian monk seals is 1,324, with a minimum population estimate of 1,261 individuals (Baker et al. 2016; Carretta et al. 2018). A comprehensive, range-wide population trend is 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 Hawaiian monk seals as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species likelihood of survival is not expected.

The 2007 Final Recovery Plan for the Hawaiian monk seal lists recovery objectives for the species. The following recovery objective is relevant to the impacts of the proposed action:

- Ensure the continued natural growth of the Hawaiian monk seal in the Main Hawaiian Islands by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human domestic animal diseases.

Because no mortalities or effects on the distribution of Hawaiian monk seal populations are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for Hawaiian monk seals. 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 Hawaiian monk seals in the wild.

11.12 Loggerhead Sea Turtle North Pacific Ocean Distinct Population Segment

No reduction in the distribution of North Pacific Ocean DPS loggerhead sea turtles from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

The North Pacific Ocean DPS of loggerhead turtle has a nesting population of about 2,300 nesting females (Matsuzawa 2011). Loggerhead turtles abundance on foraging grounds off the Pacific Coast of the Baja California Peninsula, Mexico, was estimated to be 43,226 individuals (Seminoff 2014).

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of North Pacific Ocean DPS of loggerhead turtles as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

NMFS has not prepared a Recovery Plan for the North Pacific Ocean DPS of loggerhead turtle. However, since we do not expect mortalities or effects on the distribution of North Pacific Ocean DPS loggerhead turtle populations as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for North Pacific Ocean DPS of loggerhead 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 Pacific Ocean DPS of loggerhead turtles in the wild.

11.13 Leatherback Sea Turtle

No reduction in the distribution of leatherback sea turtles from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

Leatherback populations in the Pacific are much lower than in the Atlantic, where the population has been increasing. Overall, the Pacific population has declined from an estimated 81,000 individuals to less than 3,000 total adults and sub adults (Spotila et al. 2000), and the population is believed to be declining (Tapilatu 2013).

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in the numbers or reproduction of leatherback turtles as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

The 1998 Recovery Plan for the U.S. Pacific leatherback sea turtles contains the complete down-listing/delisting criteria for the recovery goals. The following recovery objective is relevant to the impacts of the proposed action:

- Existing foraging areas are maintained as healthy environments.
- Foraging populations are exhibiting statistically significant increases at several key foraging grounds within each stock region.

Because no mortalities or effects on the distribution of leatherback turtle populations are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for leatherback 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 leatherback turtles in the wild.

11.14 Olive Ridley Sea Turtle

No reduction in the distribution of olive ridley sea turtles from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

In the eastern Pacific Ocean (excluding breeding populations in Mexico), there are arribada nesting beaches in Nicaragua, Costa Rica, and Panama. La Flor, Nicaragua had 521,440 effective nesting females in 2008 through 2009; Chacocente, Nicaragua had 27,947 nesting females over the same period (Sánchez; Janet Orozco; Wendy Gutiérrez; Danelia Mairena; Miguel Rodríguez; José Urteaga 2012). Two other arribada nesting beaches are in Nicaragua, Masachapa and Pochomil, but there are no abundance estimates available. Costa Rica hosts two major arribada nesting beaches, Ostional has between 3,564 and 476,550 turtles per arribada, and Nancite has between 256 and 41,149 sea turtles per arribada. Panama has one arribada nesting beach, with 8,768 turtles annually.

There are several solitary nesting beaches in the East Pacific Ocean (excluding breeding populations in Mexico); however, no abundance estimates are available for beaches in El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Colombia, and Ecuador. On Hawaii Beach in Guatemala, 1,004 females were recorded in 2005 (USFWS 2014).

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 olive ridley turtles as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species likelihood of survival is not expected.

The 1998 recovery plan prepared for olive ridley sea turtles found in the U.S. Pacific Ocean lists recovery objectives for the species. The following recovery objectives are relevant to the impacts of the proposed action:

- Foraging populations are statistically significantly increasing at several key foraging grounds within each stock region.

Because no mortalities or effects on the distribution of olive ridley turtle populations are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for olive ridley 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 olive ridley turtles in the wild.

11.15 Green Sea Turtle North Pacific Distinct Population Segment

No reduction in the distribution of North Pacific DPS green sea turtles from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

There are 13 known nesting sites for the Central North Pacific DPS, with an estimated 3,846 nesting females. The Central North Pacific DPS of green turtle is very thoroughly monitored, and it is believed there is little chance that there are undocumented nesting sites. The largest nesting site is at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands, which hosts 96 percent of the nesting females for the Central North Pacific DPS. Nesting abundance at East Island, French Frigate Shoals, increases at 4.8 percent annually (Seminoff 2015).

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of Central North Pacific DPS of green turtles as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species likelihood of survival is not expected.

The 1998 Recovery Plan for the U.S. Pacific Populations of the 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 Central North Pacific DPS of green turtle populations are expected because of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for Central North Pacific DPS of green 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 Central North Pacific DPS of green turtles in the wild.

11.16 Hawksbill Sea Turtle

No reduction in the distribution of hawksbill sea turtles from the Pacific Ocean is expected because of the NSF-funded seismic research activities and the Permits and Conservation Division's issuance of an incidental harassment authorization.

In the Pacific Ocean, Hawaii hosts about 20 nesting females annually, less than 30 females nest annually on the American Samoa, and less than 10 females nest each year on Guam and the Northern Mariana Islands. An estimated 300 females nest in Micronesia annually. Population trends for hawksbill sea turtles in the Pacific Ocean are not known, but are considered to be declining (NMFS 2013b).

No reduction in numbers is anticipated as part of the proposed actions. Therefore, no reduction in reproduction is expected as a result of the proposed actions. Because we do not anticipate a reduction in numbers or reproduction of hawksbill sea turtles as a result of the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization, a reduction in the species' likelihood of survival is not expected.

The 1998 Recovery Plan for U.S. Pacific Hawksbill Sea Turtles lists recovery objectives for hawksbill sea turtles in the Pacific Ocean. The following recovery objectives are relevant to the impacts of the proposed action:

- Each stock must average 1,000 females estimated to nest annually (or a biologically reasonable estimate based on the goal of maintaining a stable population in perpetuity) over six years.
- All females estimated to nest annually at "source beaches" are either stable or increasing for 25 years.
- Existing foraging areas are maintained as healthy environments.

Because no mortalities or effects on the distribution of hawksbill sea turtle populations are expected as a result of the proposed actions, we do not anticipate the proposed seismic survey activities and the Permits and Conservation Division's issuance of an incidental harassment authorization will impede the recovery objectives for hawksbill 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 hawksbill sea turtles in the wild.

11.17 Summary for ESA-listed Sea Turtles

We expect exposed leatherback, olive ridley, hawksbill, loggerhead, and green sea turtles to experience some degree of stress response upon exposure to 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, sperm, North Pacific right, Western North Pacific humpback, gray, and Main Hawaiian Islands Insular false killer whales, Hawaiian monk seals, leatherback, hawksbill, olive ridley, North Pacific Ocean DPS loggerhead, or Central North Pacific DPS green sea turtles or to destroy or adversely modify the designated critical habitat for Main Hawaiian Islands Insular false killer whales.

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.

14.1.1 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.

14.1.2 Marine Mammals

NMFS ESA Interagency Cooperation Division and Permits and Conservation Division anticipates the proposed seismic survey in the North Pacific Ocean are likely to result in the incidental take of ESA-listed marine mammals by harassment in the amounts detailed in Table 11. Behavioral (MMPA Level B) harassment is expected to occur at received levels at or above 160 dB re: 1 μ Pa (rms) for ESA-listed marine mammals. For all species of ESA-listed marine mammals, this incidental take will result from exposure to acoustic energy during airgun array operations and will be in the form of MMPA Level B harassment, and is not expected to result in the death or injury of any individuals that will be exposed.

14.1.3 Sea Turtles

We also expect individual North Central Pacific DPS of green, hawksbill, leatherback, North Pacific Ocean DPS loggerhead, and olive ridley turtles could be exposed to sounds from the airgun arrays during the course of the proposed seismic surveys that will elicit a behavioral response that will constitute harassment. No death or injury is expected for any individual sea turtle exposed to seismic survey activities.

NMFS anticipates the proposed seismic survey is likely to result in the incidental take of ESA-listed sea turtles by harassment. A behavioral response that would constitute harassment is expected to occur at received levels at or above 175 dB re: 1 μ Pa (rms) for ESA-listed sea turtles. No death or injury is expected for any individual sea turtle exposed to seismic survey activities. For the Hawaii portion of the proposed action, we expect take to be in the following amounts for ESA-listed sea turtles: 7 North Central Pacific DPS of green, 1 hawksbill, 65 leatherback, 61 North Pacific Ocean DPS loggerhead, and 32 olive ridley.

Where it is not practical to quantify the number of individuals that are expected to be taken by the action, a surrogate (e.g., similarly affected species, habitat, ecological conditions, and sound

pressure thresholds) may be used to express the amount or extent of anticipated take (50 CFR 402. §14(i)(1)(i)).

Because there are no reliable estimates of sea turtle population densities in the Emperor Seamounts action area, it is not practical to develop numerical estimates of sea turtle exposure. We are relying on the extent of the 175 dB re: 1 μ Pa (rms) ensonified areas, which include a 10.92 km² area (1.86-km distance) for the Emperor Seamounts seismic survey, based upon the propagation and trackline estimates provided by the National Science Foundation and Lamont-Doherty Earth Observatory. A sea turtle within the 175 dB re: 1 μ Pa (rms) ensonified areas during airgun array operations will 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 airguns in the array used during seismic survey activities, the tow depth of the airgun array, and the depth of the water in the action area. The water depth can change the predicted distances to which sound levels 175 dB re: 1 μ Pa (rms) are received so we are assuming the largest predicted established distances of 10.92 km² for the Emperor Seamounts seismic survey along seismic survey tracklines for the 175 dB re: 1 μ Pa (rms) buffer zone so as not to underestimate the effect of the stressor.

If the amount or location of trackline surveyed changes, or the number of seismic survey days is increased, then incidental take for marine mammals and sea turtles may be exceeded. As such, if more tracklines are surveyed, there is an increase in the number of survey days beyond the 25 percent contingency, there are greater estimates of sound propagation, and/or increases in source levels from the airgun array occur, re-initiation of consultation will be necessary. As we cannot determine the number of individual sea turtles to which harassment will occur, we expect the extent of exposure will occur within the 175 dB re: 1 μ Pa (rms) of the R/V *Marcus G. Langseth's* airgun 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

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

measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02). 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 L-DEO 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 L-DEO 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, L-DEO, 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, L-DEO, 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, L-DEO, 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 L-DEO, 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 for all ESA-listed species 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 NSF 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 NSF and the NMFS Permits and Conservation Division's actions. 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 the Lamont-Doerty Earth Observatory must comply with as part of the IHA. The text below was taken from the permit provided to us by the Permits and Conservation Division.

1. This Incidental Harassment Authorization (IHA) is valid from September 1, 2018, through August 31, 2019.
2. This IHA is valid only for marine geophysical activity as specified in L-DEO's IHA application and using an array aboard the R/V *Langseth* with characteristics specified in the IHA application, in the Pacific Ocean near the main Hawaii Islands and Emperor Seamounts.
3. General Conditions
 - (a) A copy of this IHA must be in the possession of L-DEO, the vessel operator, the lead protected species observer (PSO) and any other relevant designees of L-DEO operating under the authority of this IHA.
 - (b) The species and numbers authorized for taking are listed in Tables 1 and Tables 2 (attached).
 - (c) The taking by injury (Level A harassment), serious injury, or death of any of the species listed in condition 3(b) of the Authorization or any taking of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this IHA.
 - (d) L-DEO or the vessel operator must conduct briefings between PSOs and vessel crew prior to the start of all seismic operations, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

4. Mitigation Measures

The holder of this Authorization is required to implement the following mitigation measures:

- (a) L-DEO must use at least five dedicated, trained, NMFS-approved Protected Species Observers (PSOs). The PSOs must have no tasks other than to conduct observational effort, record observational data, and communicate with and instruct relevant vessel crew with regard to the presence of marine mammals and mitigation requirements.
- (b) At least one of the visual and two of the acoustic PSOs aboard the vessel must have a minimum of 90 days at-sea experience working in those roles, respectively, during a deep penetration seismic survey, with no more than 18 months elapsed since the conclusion of the at-sea experience

(c) Visual Observation

- (i) During survey operations (*e.g.*, any day on which use of the acoustic source is planned to occur, and whenever the acoustic source is in the water, whether activated or not), a minimum of two visual PSOs must be on duty and conducting visual observations at all times during daylight hours (*i.e.*, from 30 minutes prior to sunrise through 30 minutes following sunset) and 30 minutes prior to and during ramp-up, including nighttime ramp-ups, of the airgun array.
- (ii) Visual PSOs must coordinate to ensure 360° visual coverage around the vessel from the most appropriate observation posts, and must conduct visual observations using binoculars and the naked eye while free from distractions and in a consistent, systematic, and diligent manner.
- (iii) Visual PSOs must immediately communicate all observations to the acoustic PSO(s) on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.
- (iv) During good conditions (*e.g.*, daylight hours; Beaufort sea state (BSS) 3 or less), visual PSOs must 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.
- (v) Visual 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 of observation per 24-hour period. Combined observational duties (visual and acoustic but not at same time) may not exceed 12 hours per 24-hour period for any individual PSO

(d) Acoustic Monitoring

- (i) The source vessel must use a towed passive acoustic monitoring system (PAM) which must be monitored by, at a minimum, one on duty acoustic PSO beginning at least 30 minutes prior to ramp-up and at all times during use of the acoustic source.
- (ii) Acoustic PSOs must immediately communicate all detections to visual PSOs, when visual PSOs are on duty, including any determination by the PSO regarding species identification, distance, and bearing and the degree of confidence in the determination.

- (iii) Acoustic 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 of observation per 24-hour period. Combined observational duties may not exceed 12 hours per 24-hour period for any individual PSO.
- (iv) Survey activity may continue for 30 minutes when the PAM system malfunctions or is damaged, while the PAM operator diagnoses the issue. If the diagnosis indicates that the PAM system must be repaired to solve the problem, operations may continue for an additional five hours without acoustic monitoring during daylight hours only under the following conditions:
 - a. Sea state is less than or equal to BSS 4;
 - b. With the exception of delphinids, no marine mammals detected solely by PAM in the applicable exclusion zone in the previous two hours;
 - c. NMFS is notified via email as soon as practicable with the time and location in which operations began occurring without an active PAM system; and
 - d. Operations with an active acoustic source, but without an operating PAM system, do not exceed a cumulative total of five hours in any 24-hour period.
- (e) Exclusion zone and buffer zone
 - (i) PSOs must establish and monitor a 500 m exclusion zone and 1,000 m buffer zone. The exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters). The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 meter exclusion zone, out to a radius of 1,000 meters from the edges of the airgun array (500–1,000 meters). PSOs must monitor the beyond 1,000 meters and enumerate any takes that occur beyond the buffer zone.
- (f) Pre-clearance and Ramp-up
 - (i) A ramp-up procedure must be followed at all times as part of the activation of the acoustic source, except as described under 4(f)(vi).

- (ii) Ramp-up must not be initiated if any marine mammal is within the exclusion or buffer zone. If a marine mammal is observed within the exclusion zone or the buffer zone during the 30 minute pre-clearance period, ramp-up may not begin until the animal(s) has been observed exiting the zone or until an additional time period has elapsed with no further sightings (15 minutes for small odontocetes and pinnipeds and 30 minutes for mysticetes and large odontocetes all other species).
- (iii) Ramp-up must begin by activating a single airgun of the smallest volume in the array and must continue in stages by doubling the number of active elements at the commencement of each stage, with each stage of approximately the same duration. Duration must not be less than 20 minutes.
- (iv) PSOs must monitor the exclusion and buffer zones during ramp-up, and ramp-up must cease and the source must be shut down upon observation of a marine mammal within the exclusion zone. Once ramp-up has begun, observations of marine mammals within the buffer zone do not require shutdown or powerdown, but such observation must be communicated to the operator to prepare for the potential shutdown or powerdown.
- (v) Ramp-up may occur at times of poor visibility, including nighttime, if appropriate acoustic monitoring has occurred with no detections in the 30 minutes prior to beginning ramp-up.
- (vi) If the acoustic source is shut down for brief periods (i.e., less than 30 minutes) for reasons other than that described for shutdown and powerdown (e.g., mechanical difficulty), it may be activated again without ramp-up if PSOs have maintained constant visual and/or acoustic observation and no visual or acoustic detections of marine mammals have occurred within the applicable exclusion zone. For any longer shutdown, pre-clearance observation and ramp-up are required. For any shutdown at night or in periods of poor visibility (e.g., BSS 4 or greater), ramp-up is required, but if the shutdown period was brief and constant observation was maintained, pre-clearance watch of 30 min is not required.
- (vii) Testing of the acoustic source involving all elements requires ramp-up. Testing limited to individual source elements or strings does not require ramp-up but does require pre-clearance of 30 min.

- (g) Shutdown and Powerdown
- (i) Any PSO on duty has the authority to delay the start of survey operations or to call for shutdown or powerdown of the acoustic source if a marine mammal is detected within the 500 m exclusion zone (100 m when shutdown has been waived as described in 4(g)(v).
 - (ii) The operator must establish and maintain clear lines of communication directly between PSOs on duty and crew controlling the acoustic source to ensure that shutdown and powerdown commands are conveyed swiftly while allowing PSOs to maintain watch.
 - (iii) When the airgun array is active (i.e., anytime one or more airguns is active, including during ramp-up and powerdown) and (1) a marine mammal (excluding delphinids) appears within or enters the exclusion zone and/or (2) a marine mammal is detected acoustically and localized within the exclusion zone, the acoustic source must be shut down. When shutdown is called for by a PSO, the airgun array must be immediately deactivated. Any questions regarding a PSO shutdown must be resolved after deactivation.
 - (iv) Shutdown must occur whenever PAM alone (without visual sighting), confirms presence of marine mammal(s) (other than delphinids) in the 500 m exclusion zone. During daylight hours, if the acoustic PSO cannot confirm presence within exclusion zone, visual PSOs must be notified but shutdown is not required.
 - (v) The shutdown requirement shall be waived for small dolphins of the following genera: *Tursiops*, *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Lissodelphis*, *Stenella* and *Steno*.
 - a. The acoustic source must be powered down to 40-in³ airgun if an individual belonging to these genera is visually detected within the 500 m exclusion zone.
 - b. When the acoustic source is powered down to the 40-in³ airgun due to the presence of dolphins specified in 4(g)(v), an exclusion zone of 100 m and Level B harassment zone of 430 m will be in effect for species other than specified dolphin genera that may approach the survey vessel.
 - c. Powerdown conditions must be maintained until delphinids, for which shutdown is waived, are no longer observed within the 500 m exclusion zone, following which full-power operations may be resumed without ramp-up. Visual PSOs may elect to waive the

- powerdown requirement if delphinids for which shutdown is waived appear to be voluntarily approaching the vessel for the purpose of interacting with the vessel or towed gear, and must use best professional judgment in making this decision.
- d. If PSOs observe any behaviors in delphinids for which shutdown is waived that indicate an adverse reaction, then powerdown must be initiated.
 - e. Visual PSOs must use best professional judgment in making the decision to call for a shutdown if there is uncertainty regarding identification (i.e., whether the observed marine mammal(s) belongs to one of the delphinid genera for which shutdown is waived).
- (vi) Shutdown is required when a large whale with a calf or an aggregation of large whales is observed regardless of the distance from the *Langseth*.
 - (vii) Shutdown is required when a melon-headed whale or group of melon-headed whales is observed in the range of the Kohala resident stock. L-DEO must make a good faith effort to transit through the Kohala resident stock range during daylight hours. The Kohala resident stock boundary includes melon-headed whales off the Kohala Peninsula and west coast of Hawaii Island in less than 2,500 m of water.
 - (viii) Shutdown is required when a spinner or bottlenose dolphin or group of dolphins is observed approaching or is within the Level B harassment zone (6.7 km) in the habitat of the specific main Hawaiian Island insular stock if the authorized takes have been met for any of these stocks. The ranges of the Oahu/4-Islands and Hawaii Island insular stocks of spinner dolphin include waters within the 1,000 m isobaths of each island. Similarly, the boundaries of the Oahu and Hawaii Islands insular stocks of common bottlenose dolphins encompass areas within the 1,000 isobath of each island.
 - (ix) Upon implementation of shutdown, the source may be reactivated after the marine mammal(s) has been observed exiting the applicable exclusion zone (i.e., animal is not required to fully exit the buffer zone where applicable) or following a clearance period (15 minutes for small odontocetes and pinnipeds and 30 minutes for mysticetes and large odontocetes) with no further observation of the marine mammal(s).

- (h) Vessel operators and crews must maintain a vigilant watch for all marine mammals and slow down, stop their vessel, or alter course, as appropriate and regardless of vessel size, to avoid striking any marine mammal. A visual observer aboard the vessel must monitor a vessel strike avoidance zone around the vessel (specific distances detailed below), to ensure the potential for strike is minimized.
 - (i) Vessel speeds must be reduced to 10 kn or less when mother/calf pairs, pods, or large assemblages of any marine mammal are observed near a vessel.
 - (ii) Vessels must maintain a minimum separation distance of 100 m from large whales (i.e., sperm whales and all baleen whales).
 - (iii) Vessels must attempt to maintain a minimum separation distance of 50 m from all other marine mammals, with an exception made for those animals that approach the vessel.
 - (iv) When marine mammals are sighted while a vessel is underway, the vessel must take action as necessary to avoid violating the relevant separation distance. If marine mammals are sighted within the relevant separation distance, the vessel must reduce speed and shift the engine to neutral, not engaging the engines until animals are clear of the area. This recommendation does not apply to any vessel towing gear.
- (i) Actions to Minimize Additional Harm to Live Stranded (or Milling) Marine Mammals – In the event of a live stranding (or near-shore atypical milling) event within 50 km of the survey operations, where the NMFS stranding network is engaged in herding or other interventions to return animals to the water, the Director of OPR, NMFS (or designee) will advise L-DEO of the need to implement shutdown procedures for all active acoustic sources operating within 50 km of the stranding. Shutdown procedures for live stranding or milling marine mammals include the following:
 - (i) If at any time, the marine mammal(s) die or are euthanized, or if herding/intervention efforts are stopped, the Director of OPR, NMFS (or designee) will advise the IHA-holder that the shutdown around the animals' location is no longer needed.
 - (ii) Otherwise, shutdown procedures will remain in effect until the Director of OPR, NMFS (or designee) determines and advises the IHA-holder that all live animals involved have left the area (either of their own volition or following an intervention).

- (iii) If further observations of the marine mammals indicate the potential for re-stranding, additional coordination with the IHA-holder will be required to determine what measures are necessary to minimize that likelihood (e.g., extending the shutdown or moving operations farther away) and to implement those measures as appropriate.

5. Monitoring Requirements

The holder of this Authorization is required to conduct marine mammal monitoring during survey activity. Monitoring must be conducted in accordance with the following requirements:

- (a) The operator must provide PSOs with bigeye binoculars (e.g., 25 x 150; 2.7 view angle; individual ocular focus; height control) of appropriate quality (i.e., Fujinon or equivalent) solely for PSO use. These must be pedestal-mounted on the deck at the most appropriate vantage point that provides for optimal sea surface observation, PSO safety, and safe operation of the vessel.
- (b) The operator must work with the selected third-party observer provider to ensure PSOs have all equipment (including backup equipment) needed to adequately perform necessary tasks, including accurate determination of distance and bearing to observed marine mammals. Such equipment, at a minimum, must include:
 - (i) PAM must include a system that has been verified and tested by the acoustic PSO that will be using it during the trip for which monitoring is required.
 - (ii) At least one night-vision device suited for the marine environment for use during nighttime pre-clearance and ramp-up that features automatic brightness and gain control, bright light protection, infrared illumination, and/or optics suited for low-light situations (e.g., Exelis PVS-7 night vision goggles; Night Optics D-300 night vision monocular; FLIR M324XP thermal imaging camera or equivalents).
 - (iii) Reticle binoculars (e.g., 7 x 50) of appropriate quality (i.e., Fujinon or equivalent) (at least one per PSO, plus backups).
 - (iv) Global Positioning Units (GPS) (at least one per PSO, plus backups).
 - (v) Digital single-lens reflex cameras of appropriate quality that capture photographs and video (i.e., Canon or equivalent) (at least one per PSO, plus backups).
 - (vi) Compasses (at least one per PSO, plus backups).
 - (vii) Radios for communication among vessel crew and PSOs (at least one per PSO, plus backups).
 - (viii) Any other tools necessary to adequately perform necessary PSO tasks.

- (c) Protected Species Observers (PSOs, Visual and Acoustic) Qualifications
- (i) PSOs must be independent, dedicated, trained visual and acoustic PSOs and must be employed by a third-party observer provider.
 - (ii) PSOs must have no tasks other than to conduct observational effort (visual or acoustic), collect data, and communicate with and instruct relevant vessel crew with regard to the presence of protected species and mitigation requirements (including brief alerts regarding maritime hazards), and
 - (iii) PSOs must have successfully completed an approved PSO training course appropriate for their designated task (visual or acoustic). Acoustic PSOs are required to complete specialized training for operating PAM systems and are encouraged to have familiarity with the vessel with which they will be working.
 - (iv) PSOs can act as acoustic or visual observers (but not at the same time) as long as they demonstrate that their training and experience are sufficient to perform the task at hand.
 - (v) NMFS must review and approve PSO resumes.
 - (vi) NMFS shall have one week to approve PSOs from the time that the necessary information is submitted, after which PSOs meeting the minimum requirements shall automatically be considered approved.
 - (vii) One visual PSO with experience as shown in 4(b) shall be designated as the lead for the entire protected species observation team. The lead must coordinate duty schedules and roles for the PSO team and serve as primary point of contact for the vessel operator. To the maximum extent practicable, the lead PSO must devise the duty schedule such that experienced PSOs are on duty with those PSOs with appropriate training but who have not yet gained relevant experience.
 - (viii) PSOs must successfully complete relevant training, including completion of all required coursework and passing (80 percent or greater) a written and/or oral examination developed for the training program.
 - (ix) PSOs must have successfully attained a bachelor's degree from an accredited college or university with a major in one of the natural sciences, a minimum of 30 semester hours or equivalent in the biological sciences, and at least one undergraduate course in math or statistics.
 - (x) The educational requirements may be waived if the PSO has acquired the relevant skills through alternate experience. Requests for such a waiver

must be submitted to NMFS and must include written justification. Requests must be granted or denied (with justification) by NMFS within one week of receipt of submitted information. Alternate experience that may be considered includes, but is not limited to (1) secondary education and/or experience comparable to PSO duties; (2) previous work experience conducting academic, commercial, or government-sponsored protected species surveys; or (3) previous work experience as a PSO; the PSO should demonstrate good standing and consistently good performance of PSO duties.

(d) Data Collection

- (i) PSOs must use standardized data collection forms, whether hard copy or electronic. PSOs must record detailed information about any implementation of mitigation requirements, including the distance of animals to the acoustic source and description of specific actions that ensued, the behavior of the animal(s), any observed changes in behavior before and after implementation of mitigation, and if shutdown was implemented, the length of time before any subsequent ramp-up of the acoustic source. If required mitigation was not implemented, PSOs should record a description of the circumstances.
- (ii) At a minimum, the following information must be recorded:
 - a. Vessel names (source vessel and other vessels associated with survey) and call signs;
 - b. PSO names and affiliations;
 - c. Date and participants of PSO briefings (as discussed in General Requirement);
 - d. Dates of departures and returns to port with port name;
 - e. Dates and times (Greenwich Mean Time) of survey effort and times corresponding with PSO effort;
 - f. Vessel location (latitude/longitude) when survey effort began and ended and vessel location at beginning and end of visual PSO duty shifts;
 - g. Vessel heading and speed at beginning and end of visual PSO duty shifts and upon any line change;
 - h. Environmental conditions while on visual survey (at beginning and end of PSO shift and whenever conditions changed significantly),

- including BSS and any other relevant weather conditions including cloud cover, fog, sun glare, and overall visibility to the horizon;
- i. Factors that may have contributed to impaired observations during each PSO shift change or as needed as environmental conditions changed (e.g., vessel traffic, equipment malfunctions); and
 - j. Survey activity information, such as acoustic source power output while in operation, number and volume of airguns operating in the array, tow depth of the array, and any other notes of significance (i.e., pre-clearance, ramp-up, shutdown, testing, shooting, ramp-up completion, end of operations, streamers, etc.).
- (iii) Upon visual observation of any protected species, the following information must be recorded:
- a. Watch status (sighting made by PSO on/off effort, opportunistic, crew, alternate vessel/platform);
 - b. PSO who sighted the animal;
 - c. Time of sighting;
 - d. Vessel location at time of sighting;
 - e. Water depth;
 - f. Direction of vessel's travel (compass direction);
 - g. Direction of animal's travel relative to the vessel;
 - h. Pace of the animal;
 - i. Estimated distance to the animal and its heading relative to vessel at initial sighting;
 - j. Identification of the animal (e.g., genus/species, lowest possible taxonomic level, or unidentified) and the composition of the group if there is a mix of species;
 - k. Estimated number of animals (high/low/best);
 - l. Estimated number of animals by cohort (adults, yearlings, juveniles, calves, group composition, etc.);
 - m. Description (as many distinguishing features as possible of each individual seen, including length, shape, color, pattern, scars or markings, shape and size of dorsal fin, shape of head, and blow characteristics);

- n. Detailed behavior observations (e.g., number of blows/breaths, number of surfaces, breaching, spyhopping, diving, feeding, traveling; as explicit and detailed as possible; note any observed changes in behavior);
 - o. Animal's closest point of approach (CPA) and/or closest distance from any element of the acoustic source;
 - p. Platform activity at time of sighting (e.g., deploying, recovering, testing, shooting, data acquisition, other); and
 - q. Description of any actions implemented in response to the sighting (e.g., delays, shutdown, ramp-up) and time and location of the action.
- (iv) If a marine mammal is detected while using the PAM system, the following information should be recorded:
- a. An acoustic encounter identification number, and whether the detection was linked with a visual sighting;
 - b. Date and time when first and last heard;
 - c. Types and nature of sounds heard (e.g., clicks, whistles, creaks, burst pulses, continuous, sporadic, strength of signal);
 - d. Any additional information recorded such as water depth of the hydrophone array, bearing of the animal to the vessel (if determinable), species or taxonomic group (if determinable), spectrogram screenshot, and any other notable information.

6. Reporting

- (a) L-DEO must submit a draft comprehensive report to NMFS on all activities and monitoring results within 90 days of the completion of the survey or expiration of the IHA, whichever comes sooner. The draft report must include the following:
- (i) Summary of all activities conducted and sightings of protected species near the activities;
 - (ii) Full documentation of methods, results, and interpretation pertaining to all monitoring;
 - (iii) Summary of dates and locations of survey operations and all protected species sightings (dates, times, locations, activities, associated survey activities);
 - (iv) Geo-referenced time-stamped vessel tracklines for all time periods during which airguns were operating. Tracklines should include points recording

- any change in airgun status (e.g., when the airguns began operating, when they were turned off, or when they changed from full array to single gun or vice versa);
- (v) GIS files in ESRI shapefile format and UTC date and time, latitude in decimal degrees, and longitude in decimal degrees. All coordinates must be referenced to the WGS84 geographic coordinate system;
 - (vi) Raw observational data;
 - (vii) Summary of the information submitted in interim monthly reports as well as additional data collected as described above in Data Collection and the IHA;
 - (viii) Estimates of the number and nature of exposures that occurred above the harassment threshold based on PSO observations, including an estimate of those on the trackline but not detected;
 - (ix) Certification from the lead PSO as to the accuracy of the report
 - a. The lead PSO may submit statement directly to NMFS concerning implementation and effectiveness of the required mitigation and monitoring.
 - (x) A final report must be submitted within 30 days following resolution of any comments on the draft report.
- (b) Reporting Injured or Dead Marine Mammals
- (i) Discovery of Injured or Dead Marine Mammal – In the event that personnel involved in the survey activities covered by the authorization discover an injured or dead marine mammal, L-DEO must report the incident to the Office of Protected Resources (OPR) (301-427-8401), NMFS and the NMFS Pacific Islands Regional Stranding Coordinator (808-725-5161) as soon as feasible. The report must include the following information:
 - a. Time, date, and location (latitude/longitude) of the first discovery (and updated location information if known and applicable);
 - b. Species identification (if known) or description of the animal(s) involved;
 - c. Condition of the animal(s) (including carcass condition if the animal is dead);
 - d. Observed behaviors of the animal(s), if alive;
 - e. If available, photographs or video footage of the animal(s); and

- f. General circumstances under which the animal was discovered.
- (ii) Vessel Strike – In the event of a ship strike of a marine mammal by any vessel involved in the activities covered by the authorization, L-DEO must report the incident to OPR, NMFS and to regional stranding coordinators as soon as feasible. The report must include the following information:
 - a. Time, date, and location (latitude/longitude) of the incident;
 - b. Species identification (if known) or description of the animal(s) involved;
 - c. Vessel's speed during and leading up to the incident;
 - d. Vessel's course/heading and what operations were being conducted (if applicable);
 - e. Status of all sound sources in use;
 - f. Description of avoidance measures/requirements that were in place at the time of the strike and what additional measures were taken, if any, to avoid strike;
 - g. Environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, visibility) immediately preceding the strike;
 - h. Estimated size and length of animal that was struck;
 - i. Description of the behavior of the marine mammal immediately preceding and following the strike;
 - j. If available, description of the presence and behavior of any other marine mammals immediately preceding the strike;
 - k. Estimated fate of the animal (e.g., dead, injured but alive, injured and moving, blood or tissue observed in the water, status unknown, disappeared); and
 - l. To the extent practicable, photographs or video footage of the animal(s).
- (iii) Additional Information Requests – If NMFS determines that the circumstances of any marine mammal stranding found in the vicinity of the activity suggest investigation of the association with survey activities is warranted (example circumstances noted below), and an investigation into the stranding is being pursued, NMFS will submit a written request to the IHA-holder indicating that the following initial available information

must be provided as soon as possible, but no later than 7 business days after the request for information.

- a. Status of all sound source use in the 48 hours preceding the estimated time of stranding and within 50 km of the discovery/notification of the stranding by NMFS; and
 - b. If available, description of the behavior of any marine mammal(s) observed preceding (i.e., within 48 hours and 50 km) and immediately after the discovery of the stranding.
 - c. In the event that the investigation is still inconclusive, the investigation of the association of the survey activities is still warranted, and the investigation is still being pursued, NMFS may provide additional information requests, in writing, regarding the nature and location of survey operations prior to the time period above.
8. 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.
9. Renewals - On a case-by-case basis, NMFS may issue a second one-year IHA without additional notice when 1) another year of identical or nearly identical activities as described in the Specified Activities section is planned or 2) the activities would not be completed by the time the IHA expires and a second IHA would allow for completion of the activities beyond that described in the Dates and Duration section, provided all of the following conditions are met:
 - (a) A request for renewal is received no later than 60 days prior to expiration of the current IHA.
 - (b) The request for renewal must include the following:
 - (i) An explanation that the activities to be conducted beyond the initial dates either are identical to the previously analyzed activities or include changes so minor (e.g., reduction in pile size) that the changes do not affect the previous analyses, take estimates, or mitigation and monitoring requirements.
 - (ii) A preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

- (iii) Upon review of the request for renewal, the status of the affected species or stocks, and any other pertinent information, NMFS determines that there are no more than minor changes in the activities, the mitigation and monitoring measures remain the same and appropriate, and the original findings remain valid.

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