NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL AND CONFERENCE OPINION

Title: Biological and Conference Opinion on United States Navy's Surveillance Towed Array Sensor System Low Frequency Active Sonar Routine Training, Testing, and Military Operations from August 2017 through August 2022

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce

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1 INTRODUCTION

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 et seq.) establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies 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. 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 CFR §402.14(a)). If a Federal action agency determines that an action "may affect, but is not likely to adversely affect" endangered species, threatened species, or designated critical habitat and NMFS concurs with that determination, consultation concludes informally (50 CFR §402.14(b)).

Federal action agencies shall confer with the NMFS on any action which is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR §402.10). If requested by the Federal agency and deemed appropriate, the conference may be conducted in accordance with the procedures for formal consultation in 50 CFR §402.14.

Section 7(b)(3) of the ESA requires that at the conclusion of consultation, or conference if combined with a formal consultation, NMFS provide an opinion stating whether the Federal agency's action is likely to jeopardize ESA-listed species or destroy or adversely modify their designated critical habitat under their jurisdiction. If NMFS determines that the action is likely to jeopardize ESA-listed species or destroy or adversely modify designated critical habitat, NMFS provides a reasonable and prudent alternative that allows the action to proceed in compliance with section 7(a)(2) of the ESA. If incidental take is expected, 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 United States (U.S.) Navy requested formal consultation under section 7 of the ESA based on its determination that multiple ESA-listed species under NMFS's jurisdiction may be affected by the proposed operation of the Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar onboard four Navy vessels. NMFS Permits and Conservation Division submitted a request for formal consultation under section 7 of the ESA based on its determination that the promulgation of Federal regulations and annual issuance of letters of authorization pursuant to Federal regulations under the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. §1361 et seq.), related to the Navy's use of SURTASS LFA sonar may affect ESA-listed species. However, upon the Secretary of Defense's invocation of the MMPA National Defense Exemption effective on August 13, 2017, 16 U.S.C. § 1371(f)(1), the requirements necessitating the issuance of an MMPA permit and letters of authorization are no longer applicable. Thus, the Federal action agency for this consultation is the U.S. Navy, which proposes to operate the SURTASS LFA sonar onboard four Tactical-Auxiliary General Ocean Surveillance (T-AGOS) vessels from August 2017 through August 2022[1].

Consultation in accordance with section 7(a)(2) of the ESA (16 U.S.C. §1536 (a)(2)), associated implementing regulations (50 CFR §402), and agency policy and guidance was conducted by NMFS Office of Protected Resources ESA Interagency Cooperation Division (hereafter referred to as "we"). This biological and conference opinion (opinion) and incidental take statement were prepared in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402. This document represents NMFS' final opinion on the effects of these actions on endangered and threatened species, proposed species, and designated critical habitat for those species, and habitat proposed for designation 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

On October 4, 1999, the U.S. Navy submitted a biological evaluation to NMFS to initiate consultation under section 7 of the ESA for its SURTASS LFA sonar operations on the Research Vessel (R/V) *Cory Chouest* and the U. S. Naval Ship (USNS) *IMPECCABLE* from 2002 through 2007. The consultation also included NMFS Permits and Conservation Division's promulgation of five-year regulations valid from 2002 through 2007 under the MMPA. The MMPA regulations allowed for the issuance of annual letters of authorization to the Navy that authorized the take of marine mammals incidental to the SURTASS LFA sonar operations. NMFS

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[1] Note that as described above, the National Defense Exemption will remain in force for a period of up to two years from August 13, 2017 or until such time as the National Marine Fisheries Service issues Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities, whichever is earlier. ESA section 7(b)(4) states that take of ESA-listed marine mammals must be authorized under MMPA section 101(a)(5) before the Secretary can issue an incidental take statement for ESA-listed marine mammals. NMFS's implementing regulations for MMPA section 101(a)(5)(A) specify that a letter of authorization is required to conduct activities pursuant to any regulations for a specific activity that will "take" marine mammals. However, because the National Defense Exemption set forth in 16 U.S.C. §1371(f) has been invoked, the requirements of MMPA section 101(a)(5)(A) are not applicable. Therefore, a take authorization under section 101(a)(5) of the MMPA is not required and ESA section 7(b)(4) does not preclude issuance of an ITS while the National Defense Exemption is in force. This consultation contemplates the full five years of the Navy's proposed action, and we anticipate that the mitigation, monitoring, and reporting requirements of any Regulations and Letters of Authorization issued under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities will be consistent with the mitigation, monitoring, and reporting procedures described in the Navy's biological evaluation Navy (2016) and the National Defense Exemption. If this is not the case, the Navy must reinitiate consultation. We also anticipate that upon, or prior to, the expiration of the National Defense Exemption, the National Marine Fisheries Service Permits and Conservation Division will issue Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities.

concluded consultation with the Navy and NMFS on May 30, 2002 (NMFS 2002b). The conclusion of that consultation was that SURTASS LFA sonar routine training, testing, and military operations and the issuance of MMPA letters of authorization for this activity by NMFS were not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS or result in the destruction or adverse modification of designated critical habitat. We consulted with the Navy and NMFS Permits and Conservation Division annually prior to issuance of letters of authorization pursuant to the 2002 MMPA regulations each year from 2002 through 2007. All consultation concluded that the proposed actions would not jeopardize any ESA-listed species and would not result in the destruction or adverse modification of any designated critical habitat under NMFS jurisdiction (NMFS 2002b; NMFS 2003; NMFS 2004; NMFS 2005; NMFS 2007a).

On June 9, 2006, the Navy submitted a biological evaluation to initiate consultation under section 7 of the ESA for its SURTASS LFA sonar operations on up to four vessels from 2007 through 2012. The consultation also included NMFS Permits and Conservation Division’s promulgation of five-year regulations (72 FR 46846) valid from 2007 through 2012 under the MMPA. The MMPA regulations allowed for the issuance of annual letters of authorization to the Navy that authorized the take of marine mammals incidental to the SURTASS LFA sonar operations. NMFS concluded consultation with the Navy on August 13, 2007 (NMFS 2007c). The conclusion of that consultation was that SURTASS LFA sonar routine training, testing, and military operations and the promulgation MMPA regulations and subsequent issuance of MMPA letters of authorization for this activity by NMFS were not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS or result in the destruction or adverse modification of designated critical habitat. As with the previous five year regulations, annual consultations were conducted prior to issuance of the letters of authorization pursuant to the 2007 MMPA regulations., Each of the consultations from 2007 through 2012 concluded that the proposed actions would not jeopardize any ESA-listed species and would not result in the destruction or adverse modification of any designated critical habitat under NMFS jurisdiction (NMFS 2007a; NMFS 2008a; NMFS 2009; NMFS 2010a; NMFS 2011c).

On November 2, 2011, the Navy submitted a biological evaluation to NMFS to initiate consultation under section 7 of the ESA for its SURTASS LFA sonar operations on up to four vessels from 2012 through 2017. The consultation also included NMFS Permits and Conservation Division’s promulgation of five-year regulations valid from 2012 through 2017 under the MMPA (NMFS 2012c). The MMPA regulations allowed for the issuance of annual letters of authorization to the Navy that authorized the take of marine mammals incidental to the SURTASS LFA sonar operations. NMFS concluded consultation with the Navy on August 13, 2012. The conclusion of that consultation was that SURTASS LFA sonar routine training, testing, and military operations and the issuance of MMPA letters of authorization for this activity by NMFS are not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS or result in the destruction or adverse modification of designated critical habitat (NMFS 2012b). As with the previous two rulemakings, the Navy and NMFS conducted additional consultations prior to issuance of the annual letters of authorization pursuant to the 2012 MMPA regulations. Each of the consultations from 2012 through 2017 concluded that the proposed actions would not jeopardize any ESA-listed species and would not result in the destruction or adverse modification of any designated critical habitat under NMFS jurisdiction.

As described above, section 7 consultation was initiated for each five-year MMPA regulation and again annually for the issuance of the letters of authorization under the MMPA. In each case, the consultation concluded that the SURTASS LFA sonar routine training, testing, and military operations and the issuance of MMPA regulations and associated letters of authorization were not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. During each consultation, we reviewed annual monitoring reports from the Navy on their SURTASS LFA sonar operations and the implementation of mitigation and monitoring measures and incorporated new information to reach our conclusion. This consultation considers the continuation of the Navy's SURTASS LFA sonar routine training, testing, and military operations from 2017 through 2022.

1.2 Consultation History

This opinion is based on information provided by the U.S. Navy as well as monitoring reports and other resources. Our communication with the Navy and Permits and Conservation Division regarding this consultation is summarized as follows:

On October 3, 2016, we received a biological evaluation and request from the Navy to initiate formal ESA section 7 consultation on SURTASS LFA sonar operations that would occur from August 15, 2017, through August 14, 2022, in non-polar areas of the world's ocean, including in the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea.

On February 13, 2017, we provided comments to the Navy on the biological evaluation.

On February 22, 2017, the Navy provided responses to NMFS ESA Interagency Cooperation Division's February 13, 2017 comments.

On March 30, 2017, we provided additional comments to the Navy on the biological evaluation.

On April 5, 2017, the Navy provided responses to NMFS ESA Interagency Cooperation Division's March 30, 2017 comments.

On April 20, 2017, we received a request from the Navy to initiate formal consultation on SURTASS LFA operations that would occur from August 15, 2017, through August 14, 2018, in 15 mission areas of the western and central North Pacific and Indian Oceans.

On May 3, 2017, we received a request from NMFS Permits and Conservation Division for formal ESA section 7 consultation on their proposal to promulgate regulations and the subsequent issuance of four annual letters of authorization pursuant to the MMPA on the Navy's use of SURTASS LFA sonar aboard four vessels. The initiation package included a proposed five-year rule. The Permits and Conservation Division requested conclusion of the section 7 consultation before August 7, 2017, as they proposed to issue the final rulemaking and subsequent letters of authorization by August 11, 2017, to ensure the Navy has the letters of authorization in hand before August 14, 2017. On May 5, 2017, the Permits and Conservation Division provided additional requested information and a draft letter of authorization.

On May 12, 2017, we initiated consultation with the Navy and NMFS Permits and Conservation Division on the following actions:

1. The Navy on its general SURTASS LFA sonar operations from August 15, 2017, through August 14, 2022, in non-polar areas of the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea and on specific SURTASS LFA operations from August 15, 2017, through August 14, 2018, in 15 mission areas of the western and central North Pacific and Indian Oceans.
2. NMFS Permits and Conservation Division on its proposal to promulgate five-year MMPA regulations authorizing the Navy takes of marine mammals protected under the MMPA.
3. NMFS Permits and Conservation Division on its proposal to issue annual letters of authorization pursuant to the five-year MMPA regulations on the Navy's annual SURTASS LFA sonar operations aboard four vessels in specific operating areas.

On August 10, 2017, the Secretary of Defense invoked a national defense exemption under section 101(f) of the MMPA to cover the SURTASS LFA activities that were described in the Navy's biological evaluations (Navy 2016; Navy 2017c). Upon the invocation of the National Defense Exemption, 16 U.S.C. § 1371(f)(1), the provisions necessitating the issuance of a MMPA permit, regulations and letters of authorization do not apply.

On August 11, 2017, due to Secretary of Defense's invocation of a national defense exemption, NMFS Permits and Conservation Division requested NMFS ESA Interagency Cooperation Division suspend formal consultation on their proposal to promulgate regulations and the subsequent issuance of four annual letters of authorization pursuant to the MMPA on the Navy's use of SURTASS LFA sonar.

We prepared this opinion and incidental take statement in accordance with section 7(b) of the ESA and implementing regulations at 50 CFR Part 402.

2 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. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration.

This consultation considered the U.S. Navy's proposed action to employ SURTASS LFA sonar routine training, testing, and military operations on four vessels in non-polar regions of the world's oceans for a five year period from August 2017 through August 2022 including on an annual period with 20 nominal missions in 15 mission areas of the western and central North Pacific Ocean and Indian Ocean for no more than 255 hours of SURTASS LFA sonar transmissions per vessel per year. As described previously, the Secretary of Defense invoked a National Defense Exemption under section 101(f) of the MMPA to cover the SURTASS LFA activities that were reflected in the Navy's biological evaluation (Navy 2016).

The National Defense Exemption will remain in force for a period of up to two years from August 13, 2017, or until such time as the National Marine Fisheries Service issues Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities, whichever is earlier. ESA section 7(b)(4) states that take of ESA-listed marine mammals must be authorized under MMPA section 101(a)(5) before the Secretary can issue an incidental take statement for ESA-listed marine mammals. NMFS's implementing regulations for MMPA section 101(a)(5)(A) specify that a letter of authorization is required to conduct activities pursuant to any regulations for a specific activity that will "take" marine mammals. However, because the National Defense Exemption set forth in 16 U.S.C. §1371(f) has been invoked, the requirements of MMPA section 101(a)(5)(A) are not applicable. Therefore, a take authorization under section 101(a)(5) of the MMPA is not required and ESA section 7(b)(4) does not preclude issuance of an ITS while the National Defense Exemption is in force. This consultation contemplates the full five years of the Navy's proposed action, and we anticipate that the mitigation, monitoring, and reporting requirements of any Regulations and Letters of Authorization issued under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities will be consistent with the mitigation, monitoring, and reporting procedures described in the Navy's biological evaluation (Navy 2016) and National Defense Exemption. If this is not the case, the Navy must reinitiate consultation. We presently anticipate that upon, or prior to, the expiration of the National Defense Exemption, the National Marine Fisheries Service Permits and Conservation Division will issue Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities.

2.1 Navy's Proposed Action

The U.S. Navy's primary mission is to maintain, train, equip, and operate combat-ready naval forces capable of accomplishing America's strategic objectives, deterring maritime aggression, and assuring freedom of navigation in ocean areas. Anti-submarine warfare (i.e., long-range submarine detection) is a critical part of that mission. This mission is mandated by Federal law in 10 U.S.C. §5062, which directs the Secretary of the Navy and Chief of Naval Operations to ensure the readiness of the U.S. naval forces. Due to the advancements and use of quieting technologies in diesel-electric and nuclear submarines, undersea submarine threats have become increasingly difficult to locate solely using passive acoustic technologies. At the same time the distance decreases at which submarine threats can be detected due to quieting technologies, improvements in torpedo and missile design have extended the effective range of these weapons. To meet this need for long-range submarine detection and maintain readiness for global deployment, the Navy developed SURTASS LFA sonar and has employed it since 2002 in this capacity.

The Navy proposes to use SURTASS LFA sonar systems (LFA sonar or compact LFA sonar) on a maximum of four Naval ships during routine training, testing, and military operations. SURTASS LFA sonar is proposed for use in the Pacific, Indian, and Atlantic Oceans, as well as the Mediterranean Sea, from 2017 through 2022. The SURTASS LFA sonar system is composed of both passive (i.e., SURTASS receiver array) and active (i.e., LFA) components. A compact version of the LFA sonar system was developed as an upgrade to be used in littoral zones (e.g., shallower water environments). This version consists of smaller, lighter-weight source elements with improved reliability and ease of deployment when compared to the original SURTASS LFA sonar system. The Navy indicates that the acoustic operational characteristics of the compact version of the LFA sonar system are comparable to the existing LFA sonar systems and that the potential impacts will be similar from both. The Navy considers the littoral zone to extend to 370.4 km (200 nmi) from shore, which encompasses more than only shallow, coastal waters. The vessels are the USNS *VICTORIOUS* (T-AGOS 19), USNS *ABLE* (T-AGOS 20), USNS *EFFECTIVE* (T-AGOS 21), and USNS *IMPECCABLE* (T-AGOS 23). No more than four LFA sonar systems are expected to be in use during this period. The regular LFA sonar system will be used on the USNS *IMPECCABLE* and the compact version of the LFA sonar system will be deployed on the smaller USNS *VICTORIOUS*, USNS *ABLE*, and USNS *EFFECTIVE*. Hereafter, LFA sonar refers to both the LFA and compact LFA sonar systems.

2.1.1 Deployment

The Navy's SURTASS LFA sonar vessels usually operate independently, but may operate in conjunction with other naval air, surface, or submarine assets. The vessels generally travel in straight lines or racetrack (i.e., oval-shaped) patterns depending on the mission scenario (see Figure 1 for an example mission scenario). Each vessel is expected to spend approximately 54 days in transit between ports and operation areas as well as approximately 240 days at sea conducting routine training, testing, and military operations. Between missions, an estimated total of 71 days per year will be spent in port for upkeep and repair to maintain both the material condition of the vessel, its systems, and the morale of the crew. The maximum number of actual LFA sonar transmission hours per vessel for a one-year period will not exceed 255 hours. Therefore, the total number of actual sonar transmission hours for all four vessels will not exceed 1,020 hours over a one-year period.

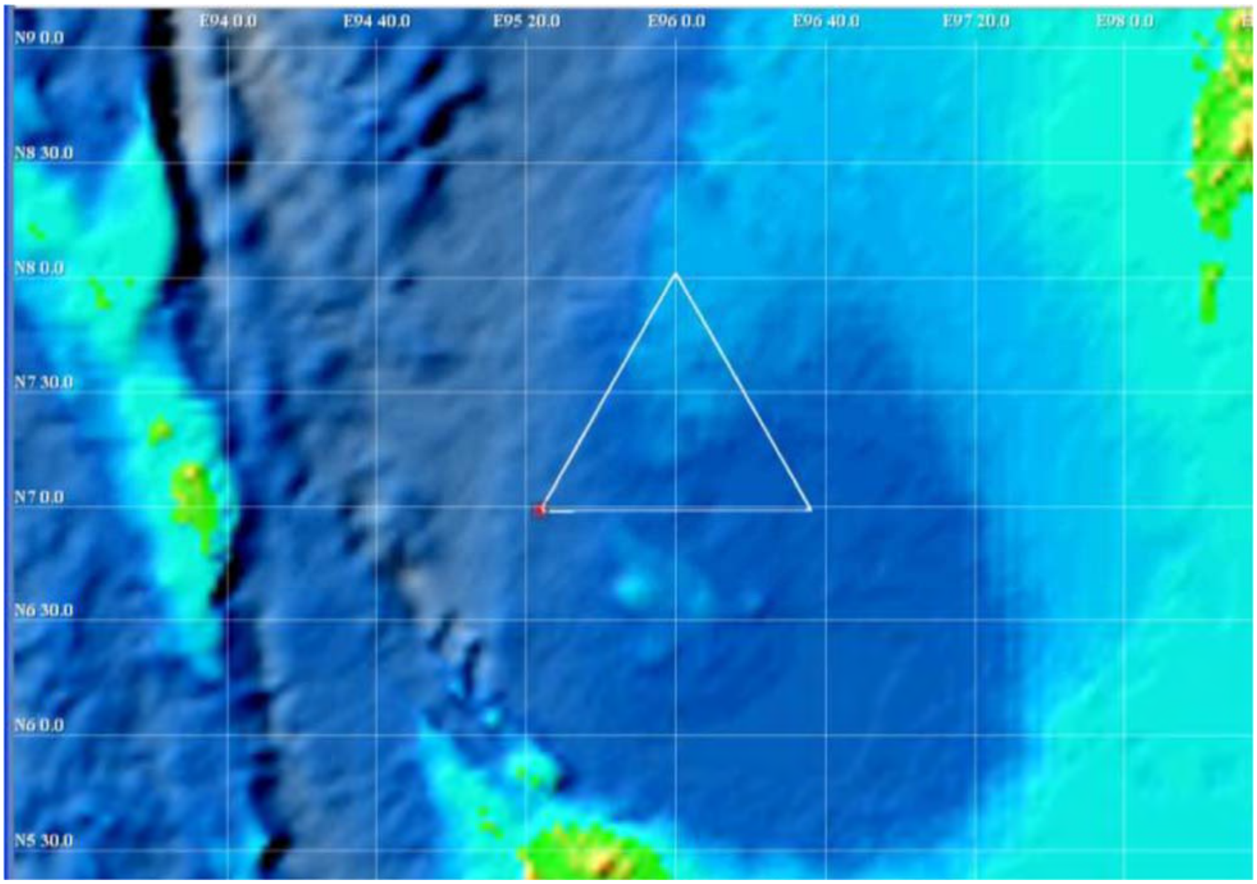

Figure 1. Modeled ship movement pattern of a U.S. Navy Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar vessel during simulated sonar operations (Navy 2012a; Navy 2017b).

Due to uncertainties in the world's political climate, a detailed account of future operating locations and conditions for SURTASS LFA sonar operations beyond the the first year is not available. However, for analytical purposes for this consultation, a nominal annual deployment schedule and operational concept were developed by the Navy, based on actual SURTASS LFA sonar operations since January 2003 and projected requirements of the fleet. The proposed action contemplates that the Navy could conduct LFA sonar missions in any of the following 26 operational mission areas:

- The western North Pacific Ocean, which includes the Sea of Okhotsk, east of Japan, North Philippine Sea, West Philippine Sea, offshore Guam, Sea of Japan, East China Sea, South China Sea, offshore Japan (25 to 40° North and 10 to 25° North), and northeast of Japan mission areas.
- The central North Pacific Ocean, which includes the northern and southern Hawaii mission areas.
- The eastern North Pacific Ocean, which includes the Gulf of Alaska, offshore Southern California, and Panama Canal mission areas.

- The southwestern Pacific Ocean, which includes the northeast Australian coast mission area.
- The Indian Ocean, which includes the Arabian Sea, Andaman Sea, and northwest Australia.
- The Atlantic Ocean, which includes the western North Atlantic (off Florida and off Norfolk, Virginia), Labrador Sea, eastern North Atlantic, Norwegian Basin, and Mediterranean Sea.

During the first year of the action, the Navy proposes an estimated combined total of 20 nominal LFA sonar missions for four SURTASS LFA sonar vessels in the 15 operational areas described below.

- Up to 16 missions in the western North Pacific Ocean, which includes the following mission areas: east of Japan, North Philippine Sea, west Philippine Sea, offshore Guam, Sea of Japan, East China Sea, South China Sea, offshore Japan (25 to 40° North and 10 to 25° North), and northeast of Japan.
- Up to two missions in the central North Pacific Ocean, which includes the northern and southern Hawaii mission areas.
- Up to two missions in the Indian Ocean, which includes the Arabian Sea, Andaman Sea, and northwest of Australia mission areas.

2.1.2 Active Sonar Components

The SURTASS LFA sonar systems are long-range sensors that operate in the low frequency band. SONAR is an acronym for SOund Navigation and Ranging, and its definition includes any system that uses underwater sound, or acoustics, for observations, monitoring, and communications. Sonar systems are used for many purposes, ranging from commercial off-the-shelf "fish finders" to military anti-submarine warfare systems for detection, tracking, and classification of underwater targets (i.e., submarines). LFA sonar complements SURTASS passive operations by actively acquiring and tracking submarines when they are in quiet operating modes, measuring accurate target range, and re-acquiring lost contacts. More information on the LFA sonar systems can be found in Navy (2012a), Navy (2016), or Navy (2017b).

The characteristics and operating features of the active acoustic component of LFA sonar are:

- The acoustic source that produces the LFA pulses or pings is a vertical line array of up to 18 source projectors suspended by cable beneath the T-AGOS vessel (Figure 2). The LFA sonar's transmitted beam is omnidirectional (360 degrees) in the horizontal plane, with a narrow vertical beamwidth that can be steered above or below the horizontal plane. To produce a pulse or ping, the projectors transform electrical energy to mechanical energy (i.e., vibrations), which travel as disturbances in the water.
- The source frequency is between 100 and 500 Hertz (Hz).

- The typical LFA sonar signal is not a constant tone, but consists of various waveforms that vary in frequency and duration. These wavetrains or pings (i.e., a complete sequence of sound transmissions) last between six and 100 seconds, with an average ping length of 60 seconds. A variety of signal types can be used within each wavetrain, including continuous wave and frequency-modulated signals. The duration of each continuous-frequency sound transmission within the wavetrain is no longer than ten seconds.
- The source level of an individual source projector of the SURTASS LFA sonar array is approximately 215 decibel (dB) re: 1 microPascal (µPa) at 1 meters (m) root mean squared (rms) or less. As measured by sound pressure level (SPL), the sound field of the array can never be higher than the source level of an individual source projector.
- The average duty cycle, which is the ratio of sound “on” time to total time, is less than 20 percent. The typical duty cycle, based on historical SURTASS LFA sonar operational parameters (2003 through 2016), is nominally 7.5 to ten percent.
- The time between wavetrain transmissions is typically from six to 15 minutes.

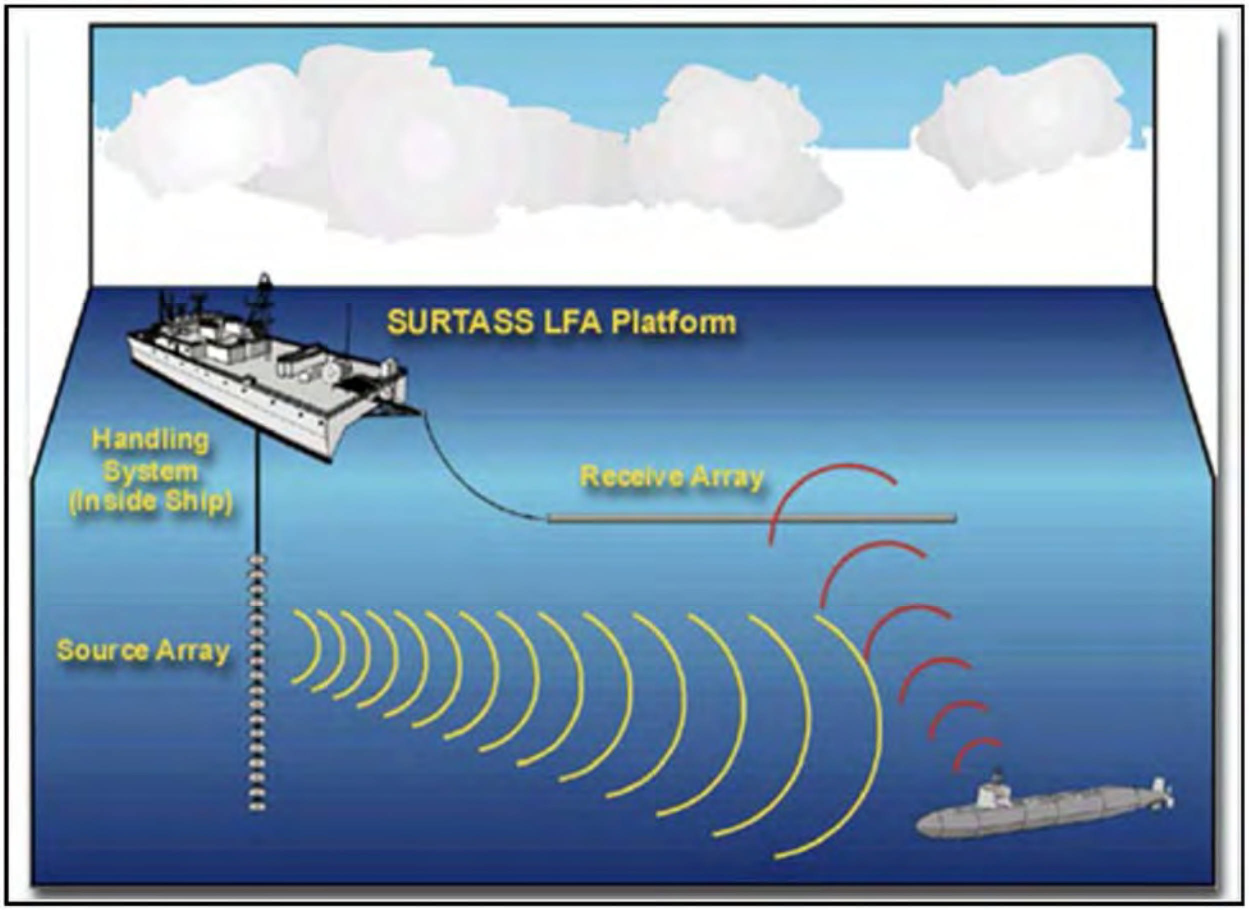

Figure 2. Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar systems showing the active (source array) and passive (receiver array) components.

2.1.3 Passive Sonar Components

The SURTASS passive, or listening, part of the system detects returning echoes or received acoustic signals from submerged objects, such as threat submarines, through the use of hydrophones. These devices transform mechanical energy (received acoustic sound waves) to an electrical signal that can be analyzed by the processing system of the sonar. Advances in passive acoustic technology have led to the development of the SURTASS Twin-Line-29A horizontal line array, a shallower water variant of the single line SURTASS system. The Twin-Line-29A consists of a “Y”-shaped array with two apertures. The array is approximately one fifth of the length of a standard SURTASS array, or approximately 305 m (1,000 ft) long, and has an operational depth of 152.4 to 457.2 m (500 to 1,500 ft). The Twin-Line-29A delivers enhanced capabilities, such as its ability to be towed in shallower water environments in the littoral zone, to provide significant directional noise rejection, and to resolve bearing ambiguities without having to change the vessel’s course. The passive capabilities of all SURTASS LFA sonar vessels have been upgraded with the installation of the Twin-Line-29A array.

The SURTASS LFA sonar vessel typically maintains a speed of at least 5.6 kilometers per hour (kph) (3 knots) through the water when towing the horizontal line array. The return signals received by the SURTASS array, which are usually below background or ambient noise level, are then processed and evaluated to identify and classify potential underwater threats or to identify biological sounds (e.g., calling marine mammals).

2.1.4 Vessel Specifications

The Navy proposes to deploy the SURTASS LFA sonar system on a maximum of four U.S. Naval ships: USNS *ABLE*, USNS *EFFECTIVE*, USNS *IMPECCABLE*, and USNS *VICTORIOUS*. The USNS *ABLE*, USNS *EFFECTIVE*, and USNS *VICTORIOUS* are twin-hulled ocean surveillance ships. Each vessel has a length of 71.6 m (235 ft), a beam of 28.5 m (93.6 ft), a maximum draft of 7.6 m (25 ft), and a full load displacement of 3,451 metric tons (3,396 tons). A twin-shaft diesel electric engine provides 3,200 horsepower, which drives two propellers. The USNS *IMPECCABLE*, is also a twin-hulled ocean surveillance ship. It has a length of 85.8 m (281.5 ft), a beam of 29.2 m (95.8 ft), a maximum draft of 7.9 m (26 ft), and a full load displacement of 5,454 metric tons (5,368 tons). A twin shaft diesel electric engine provides 5,000 horsepower, which drives two propellers. The operational speed of each vessel during LFA sonar operations will be approximately 5.6 kph (3 knots), and each vessel’s cruising speed outside of LFA sonar operations would be a maximum of approximately 18.5 to 24.1 kph (10 to 13 knots).

2.1.5 Mitigation and Monitoring

Mitigation is an action that avoids or reduces the severity of the effects of the action on ESA-listed species. Monitoring is used to observe or check the progress of the mitigation over time.

Through the course of previous SURTASS LFA sonar section 7 consultations and MMPA rule making, NMFS has worked with the Navy to identify and implement various mitigation and monitoring activities. Under the terms and conditions of the current and past biological opinions and incidental take statements, the Navy has been required to carry out all mitigation and monitoring requirements contained in the five-year regulations and annual letters of authorization issued under section 101(a)(5)(A) of the MMPA. Summaries of the results of these requirements are documented in quarterly, annual, and comprehensive reports.

Based on previous consultations, the Navy incorporated the following mitigation and monitoring measures in its proposed action for this consultation. These measures are required when SURTASS LFA sonar is transmitting to reduce the potential for injury or harassment to marine mammals and sea turtles. The Navy implements the mitigation and monitoring measures listed below. Additional detail for each mitigation and monitoring measure is described in subsequent sections of this opinion:

- Mitigation and buffer zone;
- Sound field monitoring;
- Visual monitoring;
- Passive acoustic monitoring;
- Active acoustic monitoring – high frequency/marine mammal monitoring sonar;
- Coastal and dive site restrictions;
- Offshore biologically important areas for marine mammal restrictions; and
- Annual take limit on marine mammals.

2.1.5.1 *Mitigation and Buffer Zone*

The Navy will establish mitigation and buffer zones around the LFA sonar transmit array to shut-down LFA sonar when marine mammals or other protected species are detected within these zones. The LFA sonar mitigation zone covers the ocean volume in the water column (vertically and horizontally) ensonified to received levels 180 dB re: 1 µPa (rms) sound pressure level and greater by the LFA sonar transmit array. Prior to commencing and during LFA transmission, the Navy will determine the propagation of LFA sonar signals in the ocean and the distance from the LFA sonar source to the 180 dB re: 1 µPa isopleth (i.e., the LFA sonar mitigation zone). As an added protective measure, the Navy will implement a “buffer zone” that extends an additional one km (0.5 nmi) beyond the 180 dB LFA sonar mitigation zone (i.e., the LFA sonar mitigation and buffer zone is a total of approximately 2 km [1.1 nmi] from the SURTASS LFA sonar transmit array). The buffer zone ensures that no animals are exposed to a sound pressure level greater than approximately 174 dB re: 1 µPa. The mitigation and buffer zone coincides with the full detection range of the high frequency/marine mammal monitoring (HF/M3) sonar for mitigation monitoring.

The Navy will suspend or delay SURTASS LFA sonar transmission if a marine mammal or sea turtle is detected entering or within the mitigation zone (i.e., 180 dB isopleth) plus the buffer zone. The detection of the animal may occur by any of the following mitigation-monitoring methods which are described in further detail below: visual monitoring, passive acoustic monitoring, or active acoustic monitoring. These monitoring methods will continue to be employed during the suspension or delay. The Navy may resume/commence SURTASS LFA sonar transmission 15 minutes after (1) all detected marine mammals or sea turtles have left the area of the LFA sonar mitigation zone and the one-km buffer zone; and (2) there is no further detection of any marine mammal or sea turtle within the LFA sonar mitigation zone plus the one-km buffer zone as determined by the passive acoustic or active acoustic or visual monitoring protocols.

2.1.5.2 *Sound Field Monitoring*

The Navy will conduct sound field monitoring during SURTASS LFA sonar operations. The Navy's LFA sonar technicians will estimate the received levels (i.e., sound pressure level) of the LFA sound field prior to and during LFA sonar operations to provide the information necessary to ensure that the sound field criteria (180 dB re: 1 µPa [rms] or 145 dB re: 1 µPa [rms]) are known and not exceeded, and to modify operations if needed, including the delay or suspension of LFA sonar transmissions (see *Coastal and Dive Site Restrictions* section below for rationale for the 145 dB re: µPa [rms] threshold). Sound field limits will be estimated using near real-time environmental data and underwater acoustic performance prediction models, which are an integral part of the SURTASS LFA sonar processing system. The acoustic models will help determine the LFA sonar sound field by predicting the sound pressure levels or received levels at various distances from the LFA sonar sound source. Updates to the acoustic model will nominally be made every 12 hours or more frequently, depending upon the variance in meteorological or oceanographic conditions (e.g., sea water temperature, salinity, and water depth). This information is required for LFA sonar technicians to accurately determine the speeds at which sound travels and to determine the path that the sound would take through the water column at a particular location (i.e., the speed of sound in seawater varies directly with depth, temperature, and salinity).

The purpose of the mitigation and buffer zone in previous MMPA rules for SURTASS LFA sonar operations was to reduce or alleviate the likelihood that marine mammals are exposed to levels of sound that may result in injury (i.e., permanent threshold shift [PTS]). In 2016, NMFS released revised marine mammal acoustic criteria based on new information and updated analysis. Applying the new acoustic criteria in models designed to estimate the number of marine mammals which could be affected by SURTASS LFA sonar, indicated that the mitigation zone not only precludes injury to marine mammals, but also precludes almost all temporary threshold shift (TTS) and other more severe forms of behavioral harassment. Thus, while not an expansion of the mitigation zone, this mitigation measure is now considered effective at reducing a broader range of impacts compared to prior five-year MMPA rules and letters of authorization.

2.1.5.3 *Visual Monitoring*

Visual monitoring includes daytime observations from the SURTASS LFA sonar vessels for marine mammals and sea turtles by the ship's civilian personnel or crew (i.e., observers). These individuals are trained to detect and identify marine mammals and sea turtles at the sea surface. Visual observers are required to monitor during LFA sonar operations as well as for potential vessel strikes during all times that the vessels are operating. The presence of marine mammals and sea turtles are not reported during routine visual monitoring duties when the LFA sonar is not transmitting. The length of the visual observers' shift and the assignment of breaks in this duty are the domain of the Master of each vessel, who makes these decisions regarding its personnel or crew. Visual monitoring begins 30 minutes before sunrise (nautical-twilight dawn) or 30 minutes before the first LFA sonar transmission. Visual monitoring continues for at least 15 minutes after the completion of the LFA sonar transmission exercise or until 30 minutes after sunset (nautical-twilight dusk). The objective of these visual observations is to ensure that no marine mammals or sea turtles approach close enough to enter the LFA sonar mitigation and buffer zones and to maintain a record of observed marine mammals and/or sea turtles as well as any behaviors exhibited by the animals.

Visual observations are made from the ship's bridge by designated ship personnel (i.e., observers) trained in detecting and identifying marine mammals and sea turtles. The trained visual observers maintain a topside watch and marine mammal and sea turtle observation log during any LFA sonar transmissions. The visual observers will use "big-eye" binoculars (25x150), standard handheld binoculars (7x50) and the naked eye to systematically scan the water's surface around the vessel. The "big-eye" binoculars will be used to confirm the sighting and potentially identify the animal to the species level. The sighting data entered into the log includes the number and identification (to the lowest taxon level possible) of marine mammals/sea turtles, date and time, bearing and range from vessel, type of detection (visual, passive, HF/M3 active sonar), as well as any unusual behavior (if any), and remarks or narrative (as necessary). When stationed on the bridge of the USNS *ABLE*, USNS *EFFECTIVE*, or USNS *VICTORIOUS*, the visual observer's eye level will be approximately 9.7 m (32 ft) above sea level providing an unobstructed view around the entire vessel. For the USNS *IMPECCABLE*, the visual observer's eye level will be approximately 13.7 m (45 ft) above sea level. A designated ship's officer will monitor the conduct of the visual watches and periodically review the log entries.

Visual observers are personally trained by marine biologists qualified in conducting visual monitoring for protected species from vessels at the sea surface. The trainers also have an understanding of the implementing mitigation requirements for SURTASS LFA sonar operations. Training may be conducted either in-person, or via video training. Hard and electronic copies of all training materials, including commercially available field guides, manuals, and several presentations, are provided for retention on each SURTASS LFA sonar vessel. Those training materials include copies of the Navy's Marine Species Awareness Training video (available online at: https://www.youtube.com/watch?v=KKo3r1yVBBA).

The content of training of visual observers onboard SURTASS LFA sonar vessels includes:

Training Component 1 – Observing

- Observation/search priorities – marine mammal and sea turtle detection;
- Observation goals, purpose, and rules;
- Scanning/search procedure;
    - Communication of animal detection information;
- Spotting cues;
- Factors that affect observations/ability to see animals at ocean surface;
- Recording the information you observe – data sheets;
    - Recorded information;
    - How observed/recorded information is used;
- Marine mammal behavior;
    - What is behavior;
    - "Normal" marine mammal behavior;
    - Abnormal behavior and reporting requirements;
- Injured/stranded/dead/struck marine mammals or sea turtles;
    - Procedure for injured/stranded/dead animals or ship-struck animals.

Training Component 2 – Identification of marine mammals and sea turtles

Marine mammals:

- Types of marine mammals occurring at-sea;
    - Mysticetes – baleen whales;
    - Odontocetes – whales, dolphins, and porpoises;
    - Pinnipeds – seals, sea lions, and walruses;
- Basic information and characteristics about each type of marine mammal;
- What marine mammals look like at the sea surface;
- Species likely to be seen at-sea during SURTASS LFA sonar missions;
    - Size and color;
    - Appearance at sea surface, including dive patterns/behavior, and group size;
    - Video and underwater sound (calls/vocalization) examples;

Sea turtles:

- Types of sea turtles occurring at-sea;
    - Hard-shelled sea turtles;
    - Soft-shelled sea turtles;
- Basic information about sea turtles;
- What sea turtles look like at the sea surface;

- Species likely to be seen at-sea during SURTASS LFA sonar missions;
    - Size and color;
    - Appearance at sea surface, including dive patterns/behavior, and group size;
    - Video examples.

If a potentially affected marine mammal or sea turtle is sighted outside of the LFA sonar mitigation and buffer zones, the visual observer's bridge officer notifies the Officer in Charge of the military crew. The Officer in Charge of the military crew then notifies the sonar operator for the HF/M3 sonar (discussed in more detail below) to determine the range and projected track of the animal. If it is determined that the animal will travel into the LFA sonar mitigation and buffer zones, the Officer in Charge of the military crew orders the delay or suspension of LFA sonar transmissions when the animal is observed entering the LFA sonar mitigation and buffer zone. If the animal is visually observed anywhere within the LFA sonar mitigation and buffer zone, the Officer in Charge of the military crew orders the immediate suspension of LFA sonar transmission. The observer continues visual monitoring and recording until the animal is no longer seen at the sea surface. All visual sightings are recorded in the sighting log. If a detected marine mammals or sea turtle is exhibiting abnormal behavior, visual monitoring will continue and be recorded until the behavior returns to normal or environmental conditions do not allow for monitoring to continue. If the animal continues to be detected during this time, transmissions from the LFA sonar will also remain suspended.

Visual monitoring of the LFA sonar mitigation and buffer zone by observers is effective only during daylight hours, in low Beaufort sea states, and during good weather. Given these limitations, the effectiveness of visual monitoring for marine mammals or sea turtles was estimated to be approximately nine percent (DoN 2001). This quantitative measurement of effectiveness refers to the likelihood or probability of visual observers detecting marine mammals or sea turtles at the sea surface.

2.1.5.4 *Passive Acoustic Monitoring*

Passive acoustic monitoring will be conducted using the passive (low frequency) SURTASS towed horizontal line array to listen for sounds generated by marine mammals as an indicator of their presence during LFA sonar missions. The SURTASS LFA sonar component for passive acoustic monitoring can cover a frequency of 0 to 500 Hz and is able to detect calls generated by mysticetes (i.e., baleen whales) and some odontocetes (e.g., sperm whales). If a received sound is estimated to be from a calling marine mammal within proximity of the LFA sonar vessel, the passive acoustic monitoring technician notifies the military crew office-in-charge, who in turn alerts the HF/M3 sonar operator (discussed in more detail below) and visual observers (during daylight hours) to the presence of a marine mammal. If passive acoustic monitoring detects a marine mammal prior to or during sonar transmissions, and if the the HF/M3 sonar and/or visual observers indicate that the animal enters the LFA sonar mitigation and buffer zones, the military crew orders a delay or suspension of LFA sonar transmissions . Passive acoustic monitoring technicians identify the detected calling marine mammals to species whenever possible. Passive acoustic monitoring technicians record the date, time, bearing, and species for any detections received during LFA sonar missions in a log. Information is also recorded on LFA sonar operations and visual detections of animals, and whether passive acoustic monitoring detections co-occurred in time. Passive acoustic monitoring will begin 30 minutes prior to the first LFA sonar transmission of a mission, continue throughout all LFA sonar transmissions, and end at least 15 minutes after LFA sonar transmissions are ceased. The Navy's passive acoustic monitoring technicians and LFA sonar technicians onboard the four vessels receive training in the detection of marine mammal vocalizations twice per year.

2.1.5.5 *Active Acoustic Monitoring – High Frequency/Marine Mammal Monitoring Sonar*

The Navy will also conduct active acoustic monitoring. Active acoustic monitoring uses the HF/M3 sonar (Figure 3), which is a Navy-developed, enhanced high-frequency commercial sonar designed to detect, locate, and track marine mammals (and possibly coelacanth, giant manta ray, grouper, sea turtle, shark, sturgeon, and totoaba), that may pass close enough to the SURTASS LFA sonar's transmit array to enter the LFA sonar mitigation and buffer zones and exceed the 180 dB mitigation criterion. This HF/M3 sonar operates with a similar power level, signal type, and frequency as high-frequency "fish finder"-type sonars used worldwide by both commercial and recreational fishermen. Due to the depth of the LFA sonar vertical line array, the HF/M3 sonar system was not designed to detect marine mammals or sea turtles at or near the surface in proximity to the SURTASS LFA sonar vessel. The HF/M3 sonar and its operating protocols were designed to minimize possible impacts on marine protected species.

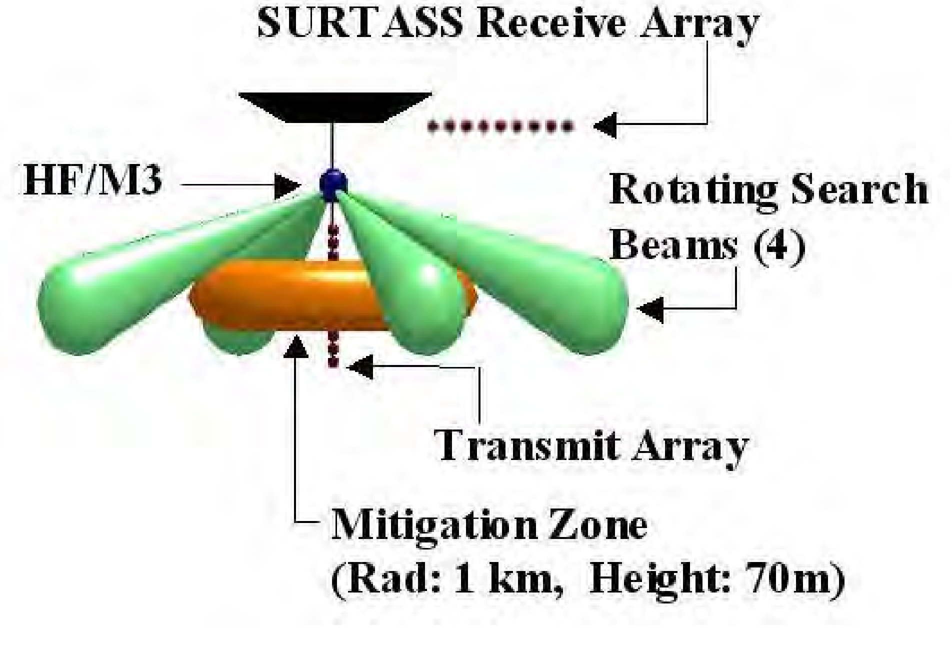

Figure 3. High Frequency/Marine Mammal Monitoring (HF/M3) sonar.

The HF/M3 sonar is located near the top of the SURTASS LFA sonar vertical line array (Figure 3), about 100 m (328.1 ft) below the sea surface. The general characteristics of the HF/M3 sonar are:

- Frequency: 30 to 40 kHz;
- Bandwidth: variable (1.5 to 6 kHz nominal);
- Duty Cycle: three to four percent (nominal);
- Nominal Source Level: 220 dB re: 1 µPa at 1 m;
- Pulse Length: variable (10 to 40 milliseconds nominal);
- Pulse Repetition Rate: set by maximum search range (three to four seconds nominal);
- Source Ramp-Up: source level of 180 dB re: 1 µPa at 1 m increasing to full power in 10 dB increments over a five minute period;
- Detection Volume: four equally spaced swept 8° (horizontal) x 10° (vertical) beams making up a 10° (vertical) sector sweep through full 360° (horizontal) around the source (i.e., omnidirectional in the horizontal, 10° vertical beamwidth); nominal time for full 360° sweep 45 to 60 seconds;
- Maximum Detection Range: nominally two km (1.08 nmi);
- Operational Depth Capability: compatible with maximum deployed depth of SURTASS LFA sonar source array;
- Vertical Steering: ±10°; and
- Receiver Gain: 23 dB (nominal versus omnidirectional noise).

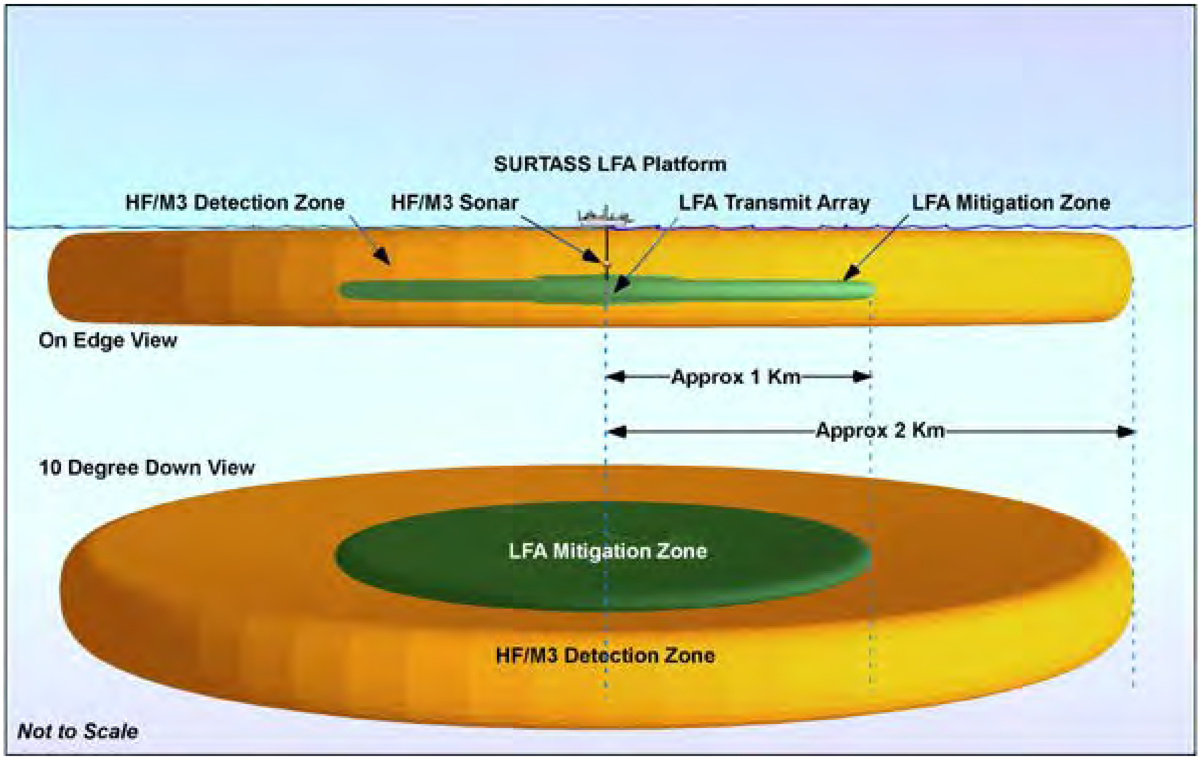

Figure 4. High Frequency/Marine Mammal Monitoring sonar system detection range and low frequency active mitigation zone.

The HF/M3 active acoustic monitoring begins 30 minutes before the first LFA sonar transmission of a given mission is scheduled to commence, continuously while the LFA sonar is active, and continues until 15 minutes after LFA sonar transmissions are terminated. Prior to full power LFA sonar operations, the power level of the HF/M3 sonar is ramped-up over a period of no less than five minutes from the source level of 180 dB re: 1 µPa at 1 m (rms) in ten-dB increments until full power (if required) is attained to ensure that there are no inadvertent exposures of local animals to received levels greater than or equal to 180 dB re: 1 µPa at 1 m (rms) from the HF/M3 sonar. The ramp-up procedure will be implemented at least 30 minutes prior to any LFA sonar transmissions, any sonar calibrations or testing that are not part of the regularly planned LFA sonar transmissions, and any time after the HF/M3 sonar has been powered-down for more than two minutes. If an animal is detected by the HF/M3 sonar during ramp-up, ramp-up may only resume once the animal is no longer detected.

Detection of a marine animal by the HF/M3 sonar automatically triggers an alert to the military crew office-in-charge, who has the HF/M3 tracking team immediately evaluate the detection. If the HF/M3 sonar detects an animal outside the LFA sonar mitigation and buffer zones, the HF/M3 sonar operator determines the range and projected track of the animal. If the operator determines that the animal will pass within the LFA sonar mitigation and buffer zones, the sonar operator notifies the military crew office-in-charge. The military crew office-in-charge will notify the bridge and passive sonar operator of the potential presence of a marine animal projected to enter the mitigation zone. The military crew office-in-charge then orders the delay or suspension of LFA sonar transmissions when the animal is predicted to enter the LFA sonar mitigation and buffer zones. Also, if a marine mammal or sea turtle is detected by the HF/M3 sonar within the LFA sonar mitigation and buffer zone, the operator notifies the military crew office-in-charge, who orders the immediate delay or suspension of transmissions. All contacts are recorded in the log.

Analysis and testing of the HF/M3 sonar system operating capabilities indicate that this system substantially increases the probability of detecting marine mammals within the LFA sonar mitigation and buffer zones and provides an excellent monitoring capability (particularly for medium to large-sized marine mammals) beyond the LFA sonar mitigation zone and within the buffer zone, out to approximately two km (1.1 nmi) (Ellison and Stein 1999). In fact, the Navy's tests have shown that the HF/M3 sonar system is nearly 100 percent effective using multiple pings in detecting marine mammals of any size (Ellison and Stein 1999).

The center of the LFA sonar array is at a nominal water depth of 122 m (400 ft), which results in a disk-shaped mitigation zone for SURTASS LFA sonar that extends horizontally 0.75 to 1 km (0.4 to 0.54 nmi) from the array and vertically from a water depth of approximately 87 to 157 m (285 to 515 ft). The HF/M3 sonar is located just above the first projector of the LFA sonar vertical line array at the nominal depth range of approximately 80 to 86 m (262 to 282 ft). The

HF/M3 sonar provides detection capability above and below the LFA sonar array, except for directly above and below. However, since the SURTRASS LFA sonar vessel and LFA and HF/M3 sonar systems are moving through the water, the “blind spots” are not stationary so that an animal would have to exactly match the ship’s course and speed while converging on the source array from above or below to avoid being detected by the HF/M3 system. Thus, there is minimal risk of an animal being undetected because it is in a blind spot.

The HF/M3 sonar system, which is positioned at the top of the LFA vertical array, also increases the likelihood of detecting large fish (e.g., coelacanth, giant manta ray, grouper, shark, sturgeon, and totoaba) and sea turtles. Sea turtles and other protected species will have to swim through the one-km HF/M3 sonar detection zone (i.e., the very same one-km buffer zone for marine mammals) where detection is highly likely, before entering the LFA sonar mitigation zone. The vertical and horizontal extent of the HF/M3 sonar detection range is greater than the volume of water ensonified to the 180 dB LFA mitigation zone.

2.1.5.6 *Coastal and Dive Site Restrictions*

Based on the analyses presented in SURTASS LFA sonar Environmental Impact Statements (Navy 2001a; Navy 2001b; Navy 2007; Navy 2012a; Navy 2017b) NMFS and the Navy have developed geographic restrictions for the SURTASS LFA sonar sound field. During SURTASS LFA sonar operations, the sound field produced by the LFA sonar (including the compact version used in littoral zones) will not exceed 180 dB re: 1 µPa (rms) SPL within 22 km (12 nmi) of any coastline (including offshore islands). This geographic restriction is known as the “coastal standoff range” for use of SURTASS LFA sonar and was established to lower the risk to many protected species. This mitigation measure is intended to minimize both the severity and scale of effects to marine mammals by avoiding the higher densities of many species that may be found in coastal areas. Additionally, this coastal restriction limits exposures of marine mammals to high-level sounds in the vicinity of geographical features that have been associated with some stranding events (i.e., enclosed bays, narrow channels, etc.).

Additionally, the Navy will operate SURTASS LFA sonar so that the sound field will not exceed received levels of 145 dB re: 1 µPa (rms) within known human recreational and commercial dive sites. Although recreational dive sites are generally located in coastal areas in waters around the shoreline out to a water depth of about 40 m (130 ft), the Navy recognizes that other dive sites may be outside this boundary. This geographic restriction is intended to protect human divers, and will also reduce the low frequency sound levels received by marine mammals located in the vicinity of known dive sites.

2.1.5.7 *Offshore Biologically Important Areas for Marine Mammals Restrictions*

Navy and NMFS developed the concept of marine mammal offshore biologically important areas (OBIA) for SURTASS LFA sonar and created a systematic process for designating OBIAs. OBIAs were developed to reduce the potential for adverse impacts. For the use of SURTASS LFA sonar, OBIAs are defined as those areas of the world’s oceans outside of the geographic stand-off range of any coastline (i.e., 22 km [12 nmi], including islands) with: (1) high densities of marine mammals; (2) known/defined breeding/calving grounds, foraging grounds, mating grounds, or migration routes; (3) small, distinct populations of marine mammals with limited distributions; or (4) designated critical habitat for ESA-listed marine mammals. The OBIAs must be inhabited, at least seasonally, by marine mammal species whose best hearing sensitivity is in the low-frequency range.

The Navy will ensure that the SURTASS LFA sonar sound field does not exceed 180 dB re: 1 µPa (rms) at least one km (0.5 nmi) seaward of the outer perimeter of any OBIAs (Navy 2016). With implementation of the one-km buffer zone, this will effectively be a 174 dB exclusion zone around any OBIA perimeter. However, during military operations, SURTASS LFA sonar transmissions may exceed 180 dB re: 1 µPa (rms) within the boundaries of an OBIA when the Navy deems it operationally necessary to continue tracking an existing underwater contact or detect a new underwater contact within the OBIA. This exception does not apply to SURTASS LFA sonar routine training and testing operations.

Under the 2012 MMPA regulations, 22 OBIAs were designated for SURTASS LFA sonar operations (Navy 2012a). As part of the preparation of the Draft SEIS/SOEIS for SURTASS LFA sonar operations from 2017 through 2022 (Navy 2017b), a comprehensive assessment of potential OBIAs was conducted by the Navy and NMFS, from which eight new candidate OBIAs, and the expansion of four existing OBIAs, were evaluated by subject matter experts. After the biological review was complete, the Navy assessed the operational practicability of the prospective areas. The Navy and NMFS then concluded that seven new OBIAs would be designated and six existing OBIAs would be expanded since the areas met the OBIA geographic, biological, and hearing criteria. Thus, a total of 28 OBIAs for SURTASS LFA sonar operations were proposed for designation in the proposed MMPA rule and described in the Navy's biological evaluation (Navy 2016). Since the proposed rule was issued, the Navy and NMFS have added one additional OBIA (i.e., Southwestern Australia Canyons). All 29 OBIAs are reflected in the National Defense Exemption.

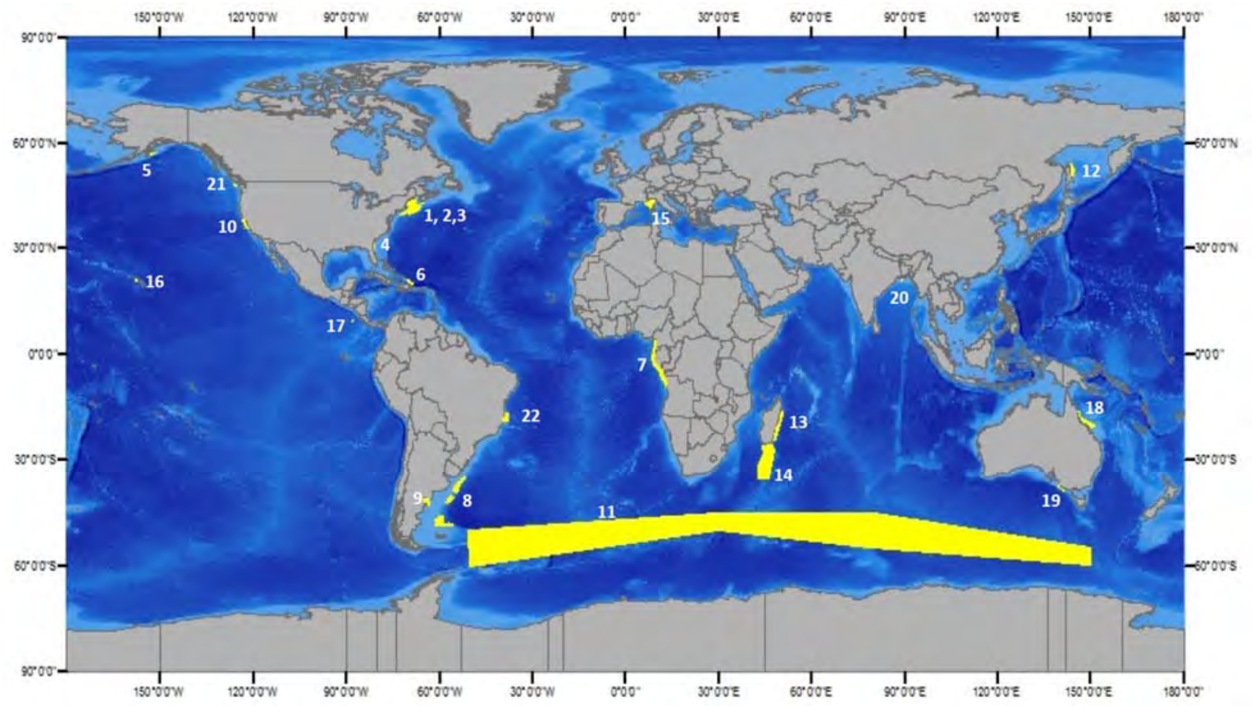

Figure 5. The locations of the 22 existing Offshore Biologically Important Areas (OBIA) for marine mammals established under the 2012 MMPA regulations for the Navy's Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar operations.

2.1.5.8 *Annual Take Limit on Marine Mammals*

The Navy will plan all SURTASS LFA sonar missions, regardless of the number of SURTASS LFA sonar vessels operating, to ensure that no more than 12 percent of any marine mammal species or stock will be taken by Level B harassment, as that term is defined under the MMPA, annually from all SURTASS LFA sonar transmissions on all four vessels. The Navy will use this annual take limit to guide its mission planning and selection of potential operational mission areas.

2.1.5.9 *Ambient Noise Data Monitoring*

Several efforts (Federal and academic) are underway to develop a comprehensive ocean noise budget (i.e., an accounting of the relative contributions of various underwater sources to the ocean noise field) for the world's oceans that include both anthropogenic and natural sources of noise. Ocean noise distributions and noise budgets are used in marine mammal masking studies, habitat characterization, and marine animal impact analyses.

The Navy will collect ambient noise data from undersea arrays. However, because the collected ambient noise data may also contain sensitive acoustic information, the Navy classifies the data, and thus does not make these data publicly available. The Navy is exploring the feasibility of declassifying and archiving portions of the ambient noise data for incorporation into appropriate ocean noise budget efforts after all related security concerns have been resolved.

2.1.6 Compliance with the Marine Mammal Protection Act

The National Marine Fisheries Service is the federal agency largely responsible for the stewardship of the nation's living marine resources and their habitat and administering the MMPA. The MMPA was enacted by Congress in 1972 due to issues concerning the well-being of marine mammals, which prompted Congress to take action. Provisions in the MMPA reflect two major conservation principles: preservation and resource management. The concept of preservation is reflected in the MMPA's permanent prohibition on the "taking" and importation of marine mammals. Under the MMPA, "take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. Due to the compelling interest in promoting the preservation of marine mammals throughout their range, these provisions apply to "any person," including the Federal government. The concept of resource management is reflected in the MMPA's exceptions to the taking prohibition and also in the authority of the Secretary of Commerce to authorize takings of marine mammals provided that certain standards are met.

Section 101(a) of the MMPA (16 U.S.C. §1372) generally prohibits the "take" of marine mammals by U.S. citizens or by any person or vessel in waters under U.S. jurisdiction (including the U.S. Gulf of Mexico), subject to certain exceptions. Among the enumerated exceptions to the take prohibition is take that is authorized under an incidental take authorization issued under either section 101(a)(5)(A) or (D) of the MMPA (16 U.S.C. §1371 (a)(5)). Authorization for incidental takings are granted if:

- NMFS finds that the taking will have a negligible impact on the species or stock(s);
- NMFS finds that the taking will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant); and
- NMFS sets forth the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings.

The National Defense Authorization Act of 2004 (Public Law 108-36) modified the MMPA by removing the "small numbers" and "specified geographic region" limitations and amended the definition of "harassment" as it applies to a "military readiness activity" to read as follows (Section 3(18)(B) of the MMPA): "(i) any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or behavioral patterns are abandoned, or significantly altered (Level B harassment)." The Navy's SURTASS LFA sonar operations are considered a "military readiness activity."

The National Defense Authorization Act also provides, under 16 U.S.C. §1371(f), that the Secretary of Defense, after conferring with the Secretary of Commerce, may exempt any action or category of actions undertaken by the Department of Defense or its components from compliance with any requirement of the MMPA, if the Secretary of Defense determines that it is necessary for national defense. As described previously, the Secretary of Defense invoked a National Defense Exemption under section 101(f) of the MMPA to cover the SURTASS LFA activities that were reflected in the Navy's biological evaluation (Navy 2016). The National Defense Exemption serves as the Navy's compliance vehicle for its MMPA obligations.

Note that the National Defense Exemption will remain in force for a period of up to two years from August 13, 2017 or until such time as the National Marine Fisheries Service issues Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities, whichever is earlier. ESA section 7(b)(4) states that take of ESA-listed marine mammals must be authorized under MMPA section 101(a)(5) before the Secretary can issue an incidental take statement for ESA-listed marine mammals. NMFS's implementing regulations for MMPA section 101(a)(5)(A) specify that a letter of authorization is required to conduct activities pursuant to any regulations for a specific activity that will "take" marine mammals. However, because the National Defense Exemption set forth in 16 U.S.C. §1371(f) has been invoked, the requirements of MMPA section 101(a)(5)(A) are not applicable. Therefore, a take authorization under section 101(a)(5) of the MMPA is not required and ESA section 7(b)(4) does not preclude issuance of an ITS while the National Defense Exemption is in force. This consultation contemplates the full five years of the Navy's proposed action and, we anticipate that the mitigation, monitoring, and reporting requirements of any Regulations and Letters of Authorization issued under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities will be consistent with the mitigation, monitoring, and reporting procedures described in the Navy's biological evaluation (Navy 2016) and National Defense Exemption. If this is not the case, the Navy must reinitiate consultation. We anticipate that upon, or prior to, the expiration of the National Defense Exemption, the National Marine Fisheries Service Permits and Conservation Division will issue Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities.

The mitigation, monitoring, and reporting requirements of the National Defense Exemption are described below.

I. PARAMETERS

1. This exemption covers use of SURTASS LFA sonar onboard the USNS VICTORIOUS (T-AGOS 19), the USNS ABLE (T-AGOS 20), the USNS EFFECTIVE (T-AGOS 21), and USNS IMPECCABLE (T-AGOS 23). The sound signals transmitted by the SURTASS LFA sonar source must be between 100 and 500 Hertz (Hz) with a source level for each of the 18 projectors of no more than 215 decibels (dB) re: 1 micro Pascal at 1 meter (m) root mean square (rms) and a maximum duty cycle of 20 percent.

2. The Navy will carry out an estimated total of 20 nominal active sonar missions annually among these four vessels (or equivalent number of shorter missions), but shall not exceed a total of 255 hours of sonar transmit time per vessel per year during the period of this exemption within the following areas:

(a) Up to 16 nominal missions annually in the western North Pacific Ocean, which includes the following mission areas: east of Japan; the north Philippine Sea; the west Philippine Sea; offshore Guam; the Sea of Japan; the East China Sea; the South China Sea; offshore Japan (25° to 40° N and 10° to 25° N), and northeast of Japan.

(b) Up to two nominal missions annually in the central North Pacific Ocean that include the Hawaii North and Hawaii South mission areas.

(c) Up to two nominal missions annually in the Indian Ocean that include the Arabian Sea, the Andaman Sea and northwest of Australia mission areas.

II. MITIGATION

1. SURTASS LFA sonar military readiness activities must be conducted in a manner that minimizes, to the greatest extent practicable, adverse impacts on marine mammals, their habitats, and the availability of marine mammals for subsistence uses. When conducting the military readiness activities, the following mitigation measures must be implemented:

(a) **Personnel Training—Lookouts**:
  (1) The Navy shall train the lookouts in the most effective means to ensure quick and effective communication within the command structure in order to facilitate implementation of protective measures if they spot marine mammals.
  (2) The Navy will employ one or more marine mammal biologists qualified in conducting at-sea marine mammal visual monitoring from surface vessels to train and qualify designated ship personnel to conduct at-sea visual monitoring. This training may be accomplished either in-person, or via video training.

(b) **General Operating Procedures**:
  (1) Prior to SURTASS LFA sonar operations, the Navy will promulgate executive guidance for the administration, execution, and compliance with this exemption.
  (2) SURTASS LFA sonar signals must not be transmitted at a frequency greater than 500 Hertz (Hz).
  (3) The Navy must ensure, to the greatest extent practicable, that no marine mammal is subjected to a sound pressure level of 180 dB re: 1 μPa (rms) or greater from SURTASS LFA sonar operations.

(c) **Commercial and Recreational SCUBA Diving Mitigation Zone**
  (1) The Navy will establish a mitigation zone for human divers at 145 dB re: 1 μPa at 1 m around all known human commercial and recreational diving sites. Although this geographic restriction is intended to protect human divers, it will also reduce the LFA sound levels received by marine mammals located in the vicinity of known dive sites

(d) **LFA Sonar Mitigation Zone and Additional 1-Kilometer (km) Buffer Zone:**

(1) Prior to commencing and during SURTASS LFA sonar transmissions, the Navy will use near real-time environmental data and underwater acoustic prediction models to determine the propagation of the SURTASS LFA sonar signals in the mission area and the distance from the SURTASS LFA sonar source to the 180-decibel (dB) re: 1 µPa isopleth (*i.e.*, the LFA sonar mitigation zone).

(2) The Navy will establish a180-dB LFA sonar mitigation zone around the surveillance vessel that is equal in size to the 180-dB re: 1 µPa isopleth (i.e., the volume subjected to sound pressure levels of 180 dB or greater) as well as establish a one-kilometer (1-km) buffer zone around the LFA sonar mitigation zone.

(3) The Navy will update these sound field estimates every 12 hours or more frequently depending upon changing meteorological or oceanographic conditions; and at least 30 minutes prior to any SURTASS LFA sonar transmission.

(e) **Ramp-Up Procedures for the HF/M3 System:**

(1) The Navy will ramp up the High Frequency/Marine Mammal Monitoring (HF/M3) active sonar from a power level beginning at a maximum source sound pressure level of 180 dB re: 1 µPa @ 1 m (rms) in 10-dB increments to operating levels over a period of no less than five minutes:

    (A) At least 30 minutes prior to any SURTASS LFA sonar transmission;

    (B) Prior to any SURTASS LFA sonar calibrations or testing that are not part of regular SURTASS LFA sonar transmissions; and

    (C) Any time after individuals have powered down the HF/M3 active sonar source for more than two minutes.

(2) The Navy will not increase the HF /M3 active sonar system's sound pressure level once HF /M3 operators detect a marine mammal. Resumption of the ramp-up of HF/M3 sonar system would not occur until marine mammals are no longer detected by the HF /M3 active sonar system, passive acoustic monitoring, or visual monitoring.

(f) **Suspension/Delay for SURTASS LFA Sonar Transmissions:**

If a marine mammal is detected through monitoring within either the LFA sonar mitigation zone or the 1-km buffer zone, the Navy will immediately suspend or delay SURTASS LFA sonar transmissions.

(g) **Resumption of SURTASS LFA Sonar Transmissions:**

The Navy may resume/commence SURTASS LFA sonar transmissions 15 minutes after:

(1) All marine mammals have left the area of the LFA sonar mitigation zone and the 1-km buffer zone; and/or

(2) There is no further detection of any marine mammal within the LFA sonar mitigation zone plus the 1- km buffer zone as determined by the passive or active acoustic or visual monitoring protocols.

(h) **Geographic Restrictions:**

(1) The Navy will not operate SURTASS LFA sonar such that: the SURTASS LFA sonar sound field exceeds 180 dB re: 1 μPa (rms):

(A) At a distance of less than or equal to 12 nautical miles (nmi) (22 km (14 miles (mi)); from any coastline, including offshore islands; and

(B) At a distance of less than 1 km (0.62 mi; 0.54 nmi) seaward of the outer perimeter of any Offshore Biologically Important Area (OBIA) for marine mammals designated in the table below ,or identified through the Adaptive Management Process, specified herein, within the period of the NDE's effectiveness.

(2) The OBIAs for marine mammals (with specified periods of effectiveness) for SURTASS LFA sonar routine training, testing, and military operations are:

Table 1. Offshore Biologically Important Areas for marine mammals.

Name of Area	**Location of Area**	**Months of Importance**
Georges Bank	Northwest Atlantic Ocean	Year-round
Roseway Basin Right Whale Conservation Area	Northwest Atlantic Ocean	June through December, annually
Great South Channel, U.S. Gulf of Maine, and Stellwagen Bank National Marine Sanctuary (NMS)	Northwest Atlantic Ocean/ Gulf of Maine	January 1 to November 14, annually Year-round for Stellwagen Bank NMS
Southeastern U.S. Right Whale Habitat	Northwest Atlantic Ocean	November 15 to January 15, annually
Gulf of Alaska	Gulf of Alaska	March through September, annually
Navidad Bank	Caribbean Sea/ Northwest Atlantic Ocean	December through April, annually
Coastal waters of Gabon, Congo and Equatorial Guinea	Southeastern Atlantic Ocean	June through October, annually
Patagonian Shelf Break	Southwestern Atlantic Ocean	Year-round
Southern Right Whale Seasonal Habitat	Southwestern Atlantic Ocean	May through December, annually
Central California	Northeastern Pacific Ocean	June through November, annually
Antarctic Convergence Zone	Southern Ocean	October through March, annually
Piltun and Chayvo offshore feeding grounds	Sea of Okhotsk	June through November, annually
Coastal waters off Madagascar	Western Indian Ocean	July through September, annually for humpback whale breeding and November through December, annually for migrating blue whales.
Madagascar Plateau, Madagascar Ridge, and Walters Shoal	Western Indian Ocean	November through December, annually
Ligurian-Corsican-Provencal Basin and Western Pelagos Sanctuary	Northern Mediterranean Sea	July to August, annually
Penguin Bank, Hawaiian Islands Humpback Whale NMS	North-Central Pacific Ocean	November through April, annually
Costa Rica Dome	Eastern Tropical Pacific Ocean	Year-round
Great Barrier Reef	Coral Sea/ Southwestern Pacific Ocean	May through September, annually
Bonney Upwelling	Southern Ocean	December through May, annually
Northern Bay of Bengal and Head of Swatch-of-No-Ground (SoNG)	Bay of Bengal/ Northern Indian Ocean	Year-round
Olympic Coast NMS and Prairie, Barkley Canyon, and Nitnat Canyon	Northeastern Pacific Ocean	Olympic NMS: December, January, March, and May annually. Prairie, Barkley Canyon, and Nitnat Canyon: June through September annually
Abrolhos Bank	Southwest Atlantic Ocean	August through November, annually
Grand Manan North Atlantic Right Whale Critical Habitat	Bay of Fundy, Canada	June through December, annually

Eastern Gulf of Mexico	Eastern Gulf of Mexico	Year-round
Southern Chile Coastal Waters	Gulf of Corcovado, Southeast Pacific Ocean; Southwestern Chile	February to April, annually
Offshore Sri Lanka	North-Central Indian Ocean	December through April, annually
Camden Sound/Kimberly Region	Southeast Indian Ocean; northwestern Australia	June through September, annually
Perth Canyon	Southeast Indian Ocean; southwestern Australia	January through May, annually
Southwest Australia Canyons	Southeast Indian Ocean; southwestern Australia	Year-round

Note: The boundaries and periods of OBIAs will be kept on file in NMFS' Office of Protected Resources and its website at http://www/nmfs.noaa.gov/pr/permits/incidental/military.htm.

(i) **Operational Exception for SURTASS LFA Sound Field in OBIAs.** During military operations, SURTASS LFA sonar transmissions may exceed 180 dB re: 1 μPa (rms) within the boundaries of an OBIA, including operating within an OBIA, when the Navy determines that it is: 1) operationally necessary to continue tracking an existing underwater contact; or 2) operationally necessary to detect a new underwater contact within the OBIA. This exception does not apply to routine training and testing with the SURTASS LFA sonar systems.

(j) **Mission Planning.** The Navy must maintain a running calculation/estimation of takes of each species and stocks over the effective period of these regulations. The Navy will plan all SURTASS LFA sonar missions to ensure that no more than 12 percent of any marine mammal species or stock would be taken by Level B harassment annually. This annual per-stock cap of 12 percent applies regardless of the number of SURTASS LFA sonar vessels operating. The Navy must coordinate to ensure that this condition is met for all vessels combined.

III. MONITORING

1. The Navy must perform:

(a) **Visual Mitigation Monitoring:**

(1) Marine mammal biologists qualified in conducting at-sea marine mammal visual monitoring from surface vessels will train and qualify designated ship personnel as lookouts to conduct at-sea visual monitoring. This training may be accomplished either in-person, or via video training.

(2) Marine mammal biologists will train the lookouts in the most effective means to ensure quick and effective communication within the ship's command structure to facilitate implementation of protective measures if they observe marine mammals.

(3) Conduct visual monitoring from the ship's bridge during all daylight hours (30 minutes before sunrise until 30 minutes after sunset). During activities that employ

SURTASS LFA sonar in the active mode, the SURTASS vessels shall have lookouts to maintain a topside watch with standard binoculars (7x) and with the naked eye.

(b) **Passive Acoustic Mitigation Monitoring:**

(1) Use the low frequency, passive SURTASS sonar system to listen for vocalizing marine mammals.

(c) **Active Acoustic Mitigation Monitoring:**

(1) Use the HF/M3 active sonar to locate and track marine mammals in relation to the SURTASS LFA sonar vessel and the sound field produced by the SURTASS LFA sonar source array, subject to the ramp-up requirements.

2. Mitigation monitoring under Conditions III.1(a), (b), and (c) must:

(a) Commence at least 30 minutes before the first SURTASS LFA sonar transmission (30 minutes before sunrise for visual monitoring);
(a) Continue between sonar transmissions (pings); and
(a) Continue either at least 15 minutes after completion of SURTASS LFA sonar transmissions (30 minutes after sunset for visual monitoring) or if marine mammals are showing abnormal behavioral patterns, for a period of time until behavior patterns return to normal or conditions prevent continued observations.

3. The Navy must:

(a) Cooperate with NMFS and any other federal agency for monitoring the impacts of the activity on marine mammals; and
(b) Designate qualified on-site individuals to conduct the mitigation, monitoring, and reporting activities specified in this NDE.

4. The Navy will conduct all monitoring required under this NDE to increase knowledge of the affected marine mammal species. The Navy must:

(a) Consider recommendations on the different types of monitoring/research that could increase the understanding of the potential effects of SURTASS LFA sonar transmissions on beaked whales and/or harbor porpoises.
(b) Continue to assess data from the Navy Marine Mammal Monitoring (M3) program and work toward making some portion of that data, after appropriate security reviews, available to scientists with appropriate clearances. Any portions of the analyses conducted by these scientists based on these data that are determined to be unclassified after appropriate security reviews should be made publicly available.

(c) Continue to collect ambient noise data and explore the feasibility of declassifying and archiving the ambient noise data for incorporation into appropriate ocean noise research efforts.

IV. REPORTING

1. **Classified and Unclassified Quarterly Reports.** The Navy must submit classified and unclassified quarterly mission reports to the Director, Office of Protected Resources, NMFS no later than 45 days after the end of each quarter, beginning on the date of effectiveness of this NDE. Each quarterly mission report will include summaries of all active-mode sonar missions completed during that quarter. At a minimum, each classified mission report must contain the following information:

   (a) Dates, times, and location of each vessel during each mission.
   (b) Information on sonar transmissions during each mission and records of any delays or suspensions.
   (c) Location of the SURTASS LFA sonar mitigation and buffer zones in relation to the LFA sonar array.
   (d) Marine mammal observations including animal type and/or species, number of animals sighted, date and time of observations, type of detection (visual, passive acoustic, HF/M3 sonar), bearing and range from vessel, abnormal behavior (if any), and remarks/narrative (as necessary).
   (e) The report will include the Navy's estimates of the percentages of marine mammal stocks affected (both for the quarter and cumulatively for the year) by SURTASS LFA sonar military readiness activities (both within and outside the LFA sonar mitigation and buffer zones), using predictive modeling based on mission locations, dates/times of operations, system characteristics, LF A sonar transmission durations, oceanographic environmental conditions, and animal demographics.
   (f) If no SURTASS LFA sonar missions are completed during a quarter, a report of negative activity will be provided.

2. **Annual Unclassified Report.** The Navy must submit an annual, unclassified report to the Director, Office of Protected Resources, NMFS, no later than 60 days after the annual anniversary of the execution of this NDE. At a minimum, the annual report will contain the following:

   (a) An unclassified summary of the year's quarterly reports.
   (b) The Navy's estimates of the percentages of marine mammal stocks affected by SURTASS LFA sonar military readiness activities (both within and outside the LFA sonar mitigation and buffer zones), using predictive modeling based on mission locations, dates/times of operations, system characteristics, LFA sonar transmission durations, oceanographic environmental conditions, and animal demographics.

   (c) An analysis of the effectiveness of the mitigation measures with recommendations for improvements, where applicable.
   (d) An assessment of any long-term effects from SURTASS LFA sonar military readiness activities a.
   (e) Any discernible or estimated cumulative impacts from SURTASS LFA sonar military readiness activities.

3. **Status on Marine Mammal Monitoring (M3) Program.** The Navy must provide a status update to NMFS, in proximity to the annual anniversary of the execution of this NDE, on efforts to assess the data collected by the Marine Mammal Monitoring (M3) program and progress toward making some portion of that data, after appropriate security reviews, available to scientists with appropriate clearances. Any portions of the analyses conducted by these scientists based on these data that are determined to be unclassified after appropriate security reviews should be made publicly available. The status update may be submitted with the Navy's annual unclassified report.

4. **Marine Mammal Ship Strike Reporting**. In the event of a ship strike by the SURTASS LFA sonar vessel, at any time or place, the Navy must:

   (a) Immediately, or as soon as clearance procedures allow, report to NMFS the species identification (if known), the size and length of the animal, location (lat/long) of the animal (or the strike if the animal has disappeared), whether the animal is alive or dead (or unknown), including an estimate of its injury status if alive (injured but alive, injured and moving, unknown, etc.).
   (b) Report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Dale.Youngkin@noaa.gov.
   (c) Report as soon as feasible to the NMFS the vessel's name, class/type, and length, as well as operational status, speed and vessel heading.
   (d) Provide NMFS a photo or video of the struck animal, if equipment is available.

5. **Marine Mammal Stranding Reporting.** During SURTASS LFA sonar military readiness activities personnel onboard a SURTASS LFA vessel shall systematically observe for injured or disabled marine mammals and monitor the principal marine mammal stranding networks and other media to correlate analysis of any whale strandings that could potentially be associated with SURTASS LFA sonar activities, the Navy shall:

   (a) Ensure that NMFS is notified immediately, or as soon as clearance procedures allow, if an injured, stranded, or dead marine mammal is observed during or shortly after (within 24 hours) and in the vicinity of any SURTASS LFA sonar activities. The Navy will report the incident to the Chief, Permits and Conservation Division, Office of Protected

Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Dale.Youngkin@noaa.gov.

(b) Provide NMFS with species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

(c) In the event that personnel onboard a SURTASS LFA vessel observe an injured, stranded, or dead marine mammal during transit, or that is not in the vicinity of, or found during or shortly after SURTASS LFA sonar military readiness activities, the Navy will report the same information to NMFS as listed above as soon as operationally feasible and clearance procedures allow.

2.1.7 Marine Mammal Take Estimates

As described in section 2.1.1 previously, the Navy could operate in all non-polar areas of the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea. It is not feasible for the Navy or NMFS to estimate take of all marine mammal species and stocks for all potential global mission areas for all seasons. For this reason, the Navy selected 26 mission areas representative of the different geographic locations where the Navy may operate SURTASS LFA sonar over the next five years. In each of these mission areas, the Navy estimated take of marine mammal species (see section 3.1.1 for a description of the process used to estimate take of marine mammals for the proposed rule) for a single 24 hour transmission in that location. These take estimates are provided below. This provides a reasonable upper estimate for worldwide SURTASS LFA sonar operations. The locations (latitude/longitude of the center) of the 26 modeled mission areas are described in the Navy's biological evaluation (Navy 2016). Within each of these mission areas, the Navy will ensure that cumulatively no more than 12 percent of any marine mammal species or stock would be taken by Level B Harassment annually from all SURTASS LFA sonar transmissions on all four vessels. The Navy will use this annual take limit to guide its mission planning and selection of potential operational mission areas. Modeling was informed by previous SURTASS LFA operations, assumed mitigation effectiveness, and monitoring. Below we provide the take estimates for ESA-listed marine mammals that were modeled by the Navy (Table 2 through Table 27).

Table 2. Estimated Level B Harassment for Mission Area 1, East of Japan.

East of Japan – Mission Area 1 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	<0.01 (<0.01/<0.01)
Fin Whale	0.0079 (0.0071/0.0007)
Humpback Whale – WNP DPS	0.0563 (0.0482/0.0082)

North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sei Whale	0.0368 (0.0336/0.033)
Sperm Whale	0.0035 (0.0035/0.0000)

WNP=Western North Pacific

Table 3. Estimated Level B Harassment for Mission Area 2, North Philippine Sea.

North Philippine Sea – Mission Area 2 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0005 (0.0004/0.0001)
Fin Whale	<0.01 (<0.01/<0.01)
Humpback Whale – WNP DPS	0.3586 (0.2695/0.0891)
North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0034 (0.0034/0.0000)

WNP=Western North Pacific

Table 4. Estimated Level B Harassment for Mission Area 3, West Philippine Sea.

West Philippine Sea – Mission Area 3 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0007 (0.0005/0.0002)
Fin Whale	<0.01 (<0.01/<0.01)
Humpback Whale – WNP DPS	0.5137 (0.3507/0.1630)
Sperm Whale	0.0029 (0.0029/0.0000)

WNP=Western North Pacific

Table 5. Estimated Level B Harassment for Mission Area 4, Offshore Guam.

Offshore Guam – Mission Area 4 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	<0.01 (<0.01/<0.01)
Fin Whale	<0.01 (<0.01/<0.01)
Humpback Whale – WNP DPS	<0.01 (<0.01/<0.01)

Sei Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0024 (0.0024/0.0000)

WNP=Western North Pacific

Table 6. Estimated Level B Harassment for Mission Area 5, Sea of Japan.

Sea of Japan – Mission Area 5 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Fin Whale	0.1812 (0.0789/0.1024)
Gray Whale – WNP Population	0.0113 (0.0090/0.0023)
North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0092 (0.0092/0.0000)
Spotted Seal – Southern DPS	0.0002 (0.0002/0.0000)

WNP=Western North Pacific

Table 7. Estimated Level B Harassment for Mission Area 6, East China Sea.

East China Sea – Mission Area 6 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Fin Whale	0.2427 (0.1091/0.1336)
Gray Whale – WNP Population	<0.01 (<0.01/<0.01)
North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0035 (0.0035/0.0000)
Spotted Seal – Southern DPS	0.0027 (0.0025/0.0001)

WNP=Western North Pacific

Table 8. Estimated Level B Harassment for Mission Area 7, South China Sea.

South China Sea – Mission Area 7 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Fin Whale	0.0058 (0.0049/0.0009)
Gray Whale – WNP Population	0.0136 (0.0117/0.0019)
Humpback Whale – WNP DPS	0.0591 (0.0544/0.0048)

North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0023 (0.0023/0.0000)

WNP=Western North Pacific

Table 9. Estimated Level B Harassment for Mission Area 8, Offshore Japan (25 to 40° North).

Offshore Japan (25 to 40° North) – Mission Area 8 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	<0.01 (<0.01/<0.01)
Fin Whale	0.0145 (0.0117/0.0028)
Humpback Whale – WNP DPS	0.4503 (0.3110/0.1394)
Sei Whale	0.0322 (0.0255/0.0066)
Sperm Whale	0.0044 (0.0044/0.0000)
Hawaiian Monk Seal	0.0412 (0.0403/0.0009)

WNP=Western North Pacific

Table 10. Estimated Level B Harassment for Mission Area 9, Offshore Japan (10 to 25° North).

Offshore Japan – Mission Area 9 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0007 (0.0004/0.0003)
Fin Whale	0.0007 (0.0004/0.0003)
Humpback Whale – WNP DPS	0.2594 (0.1262/0.1333)
Sei Whale	0.3171 (0.1729/0.1442)
Sperm Whale	0.0046 (0.0046/0.0000)

WNP=Western North Pacific

Table 11. Estimated Level B Harassment for Mission Area 10, Hawaii North.

Hawaii North – Mission Area 10 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**

Blue Whale	<0.01 (<0.01/<0.01)
False Killer Whale – MHI Insular DPS	0.0089 (0.0089/0.0000)
Fin Whale	<0.01 (<0.01/<0.01)
Sei Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0826 (0.0826/0.0000)
Hawaiian Monk Seal	0.1341 (0.1310/0.0031)

MHI=Main Hawaiian Islands

Table 12. Estimated Level B Harassment for Mission Area 11, Hawaii South.

Hawaii South – Mission Area 11 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.1966 (0.1122/0.0845)
False Killer Whale – MHI Insular DPS	0.0562 (0.0562/0.0000)
Fin Whale	0.1826 (0.1094/0.0732)
Sei Whale	01937 (0.1121/0.0816)
Sperm Whale	0.0550 (0.0550/0.0000)
Hawaiian Monk Seal	0.0076 (0.0070/0.0006)

MHI=Main Hawaiian Islands

Table 13. Estimated Level B Harassment for Mission Area 12, Offshore Southern California.

Offshore Southern California – Mission Area 12 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0122 (0.0105/0.0017)
Fin Whale	0.0034 (0.0028/0.0006)
Gray Whale – WNP Population	0.0015 (0.0015/0.0000)
Humpback Whale – Central America DPS (90%) and Mexico DPS (20%)	0.0112 (0.0040/0.0072)
Sei Whale	0.0466 (0.0400/0.0066)
Sperm Whale	0.3340 (0.3340/0.0000)
Guadalupe Fur Seal	0.0259 (0.0259/0.0000)

WNP=Western North Pacific

Table 14. Estimated Level B Harassment for Mission Area 13, Western North Atlantic (Off Florida).

Western North Atlantic (Off Florida) – Mission Area 13 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
North Atlantic Right Whale	0.0368 (0.0160/0.0208)
Sperm Whale	0.0903 (0.0903/0.0000)

Table 15. Estimated Level B Harassment for Mission Area 14, Eastern North Atlantic.

Eastern North Atlantic – Mission Area 14 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.1948 (0.0219/0.1729)
Fin Whale	1.6729 (0.1355/1.5374)
Humpback Whale – Cape Verdes/Northwest Africa DPS (1%)	0.0169 (0.0018/0.0152)
Sei Whale	0.2872 (0.0487/0.2385)
Sperm Whale	0.0837(0.0837/0.0000)

Table 16. Estimated Level B Harassment for Mission Area 15, Mediterranean Sea.

Mediterranean Sea – Mission Area 15 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Fin Whale	1.7050 (0.7794/0.9256)
Sperm Whale	1.4879 (1.4879/0.0000)

Table 17. Estimated Level B Harassment for Mission Area 16, Arabian Sea.

Arabian Sea – Mission Area 16 24 Hour Transmissions

Species	Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)
Blue Whale	0.0053 (0.0043/0.0010)
Fin Whale	0.1985 (0.1652/0.0332)
Humpback Whale – Arabian Sea DPS	0.1756 (0.1512/0.0244)
Sperm Whale	0.0841 (0.0841/0.0000)

Table 18. Estimated Level B Harassment for Mission Area 17, Andaman Sea.

Andaman Sea – Mission Area 17 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0009 (0.0006/0.0003)
Fin Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0063 (0.0063/0.0000)

Table 19. Estimated Level B Harassment for Mission Area 18, Panama Canal (West Approach).

Panama Canal (West Approach) – Mission Area 18 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0293 (0.0173/0.0120)
Fin Whale	<0.01 (<0.01/<0.01)
Humpback Whale – Central America DPS	0.0140 (0.0079/0.0061)
Sperm Whale	0.0549 (0.0549/0.0000)

Table 20. Estimated Level B Harassment for Mission Area 19, Northeast Australia Coast.

Northeast Australia Coast – Mission Area 19 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**

Blue Whale	0.0009 (0.0003/0.0005)
Fin Whale	0.0182 (0.0063/0.0119)
Sei Whale	0.0677 (0.0247/0.0429)
Sperm Whale	0.0027 (0.0027/0.0000)

Table 21. Estimated Level B Harassment for Mission Area 20, Northwest Australia.

Northwest Australia – Mission Area 20 **24 Hour Transmissions**	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	<0.01 (<0.01/<0.01)
Fin Whale	0.0001 (0.0001/0.0000)
Sei Whale	0.0005 (0.0004/0.0001)
Sperm Whale	0.0094 (0.0094/0.0000)

Table 22. Estimated Level B Harassment for Mission Area 21, Northeast of Japan.

Northeast of Japan – Mission Area 21 **24 Hour Transmissions**	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0240 (0.0032/0.0207)
Fin Whale	0.4586 (0.0663/0.3923)
Gray Whale – WNP Population	0.0126 (0.0086/0.0040)
Humpback Whale – WNP DPS	4.2822 (0.1242/4.1580)
North Pacific Right Whale	0.3888 (0.0248/0.3640)
Sei Whale	0.6061 (0.0877/0.5184)
Sperm Whale	0.0289 (0.0289/0.0000)
Steller Sea Lion – Western DPS	0.0004 (0.0004/0.0000)

WNP=Western North Pacific

Table 23. Estimated Level B Harassment for Mission Area 22, Gulf of Alaska.

Gulf of Alaska – Mission Area 22 **24 Hour Transmissions**

Species	Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)
Blue Whale	<0.01 (<0.01/<0.01)
Fin Whale	7.5395 (1.1227/6.4168)
Humpback Whale – Mexico DPS (10.5%) and WNP DPS (0.5%)	0.0054 (0.0030/0.0024)
North Pacific Right Whale	3.0615 (1.9699/1.0916)
Sei Whale	3.0725 (1.4725/1.6000)
Sperm Whale	0.0148 (0.0148/0.0000)
Steller Sea Lion – Western DPS	0.3124 (0.3124/0.0000)

WNP=Western North Pacific

Table 24. Estimated Level B Harassment for Mission Area 23, Norwegian Basin.

Norwegian Basin – Mission Area 23 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.0154 (0.0108/0.0047)
Fin Whale	0.4705 (0.2578/0.2126)
Humpback Whale – Cave Verdes Islands/Northwest Africa DPS (1%)	0.0083 (0.0071/0.0012)
Sei Whale	0.0008 (0.0007/0.0001)
Sperm Whale	0.2627 (0.2627/0.0000)

Table 25. Estimated Level B Harassment for Mission Area 24, Western North Atlantic (off Norfolk, Virginia).

Western North Atlantic (Off Norfolk, Virginia) – Mission Area 24 24 Hour Transmissions	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Fin Whale	0.2491 (0.1852/0.0640)
North Atlantic Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	1.5558 (1.5558/0.0000)

Table 26. Estimated Level B Harassment for Mission Area 25, Labrador Sea.

Labrador Sea – Mission Area 25 **24 Hour Transmissions**	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Blue Whale	0.7583 (0.0973/0.6610)
Fin Whale	0.6488 (0.0998/0.5490)
North Atlantic Right Whale	<0.01 (<0.01/<0.01)
Sei Whale	0.3834 (0.0467/0.3367)
Sperm Whale	0.8136 (0.8136/0.0000)
Ringed Seal – Arctic DPS	0.4178 (0.3948/0.0230)

Table 27. Estimated Level B Harassment for Mission Area 26, Sea of Okhotsk.

Sea of Okhotsk – Mission Area 26 **24 Hour Transmissions**	
Species	**Total Take Estimates by Level B Harassment – Percent Stock or DPS Affected (Behavior/TTS)**
Bowhead Whale	0.0191 (0.0005/0.0186)
Fin Whale	0.0143 (0.0004/0.0139)
Gray Whale – WNP Population	<0.01 (<0.01/<0.01)
Humpback Whale – WNP DPS	0.4880 (0.0073/0.4807)
North Pacific Right Whale	<0.01 (<0.01/<0.01)
Sperm Whale	0.0023 (0.0023/0.0000)
Bearded Seal – Okhotsk DPS	0.0220 (0.0215/0.0005)
Ringed Seal – Okhotsk DPS	0.1439 (0.1425/0.0014)
Steller Sea Lion – Western DPS	0.0815 (0.0815/0.0000)

WNP=Western North Pacific

Due to uncertainties in the world’s political climate, a detailed account of future operating locations and conditions for SURTASS LFA sonar operations beyond this upcoming year are not available. The following are estimates of the amount of take of marine mammals (Table 28 through Table 42) for the first year of the proposed action.

Because the locations of Navy SURTASS LFA sonar operations have changed minimally since 2002, this consultation assumed that future take (e.g., for years two through five of the proposed action) by MMPA Level B harassment, will occur in the same mission areas as those anticipated in the first year. While the mission areas are not expected to change, the amount of marine mammal take that is reasonably certain to occur could vary from year to year (though no more than 12 percent of any particular species or stock will be taken by Level B harassment annually). This consultation considered the upper limits of potential takes of marine mammals for the duration of the proposed action and into the reasonably foreseeable future and assumed, based on Navy's operational history, that the SURTASS LFA sonar mission areas will not change from those proposed in the first year. If the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, such a change would require additional consultation under section 7 of the ESA that tiers off of the programmatic analysis in this consultation.

Table 28. Estimated Level B Harassment for Mission Area 1, East of Japan.

East of Japan – Mission Area 1 **1.5 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (<0.01)
Fin Whale	2 (0.02)
Humpback Whale – WNP DPS	1 (0.08)
North Pacific Right Whale	1 (<0.01)
Sei Whale	12 (0.15)
Sperm Whale	32 (0.03)

WNP=Western North Pacific

*Although North Pacific right whales potentially occur in the East of Japan mission area in the fall through spring seasons, because the Navy modeled and presented take estimates for the summer season in this mission area when the North Pacific right whale does not occur, no take estimate was provided for this species. However, because North Pacific right whales are known to occur in low densities in the waters of this mission area during seasons that were not modeled (i.e., fall through spring), we estimate one North Pacific right whale take will occur in this mission area.

Table 29. Estimated Level B Harassment for Mission Area 2, North Philippine Sea.

North Philippine Sea – Mission Area 2 **3 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (<0.01)
Fin Whale	8 (0.08)

Humpback Whale – WNP DPS	48 (4.39)
North Pacific Right Whale	1 (0.03)
Sperm Whale	73 (0.03)

WNP=Western North Pacific

Table 30. Estimated Level B harassment for Mission Area 3, West Philippine Sea.

West Philippine Sea – Mission Area 3 **3 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (<0.01)
Fin Whale	7 (0.07)
Humpback Whale – WNP DPS	51 (4.69)
Sperm Whale	65 (0.04)

WNP=Western North Pacific

Table 31. Estimated Level B Harassment for Mission Area 4, Offshore Guam.

Offshore Guam – Mission Area 4 **3 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (<0.01)
Fin Whale	2 (<0.01)
Humpback Whale – WNP DPS	4 (0.67)
Sei Whale	4 (0.06)
Sperm Whale	53 (0.06)

WNP=Western North Pacific

Table 32. Estimated Level B Harassment for Mission Area 5, Sea of Japan.

Sea of Japan – Mission Area 5 **1 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Fin Whale	109 (1.17)

Gray Whale – WNP Population	1 (0.05)
North Pacific Right Whale	0 (<0.01)
Sperm Whale	66 (0.06)
Spotted Seal – Southern DPS	1 (<0.01)

WNP=Western North Pacific

Table 33. Estimated Level B Harassment for Mission Area 6, East China Sea.

East China Sea – Mission Area 6 **1 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Fin Whale	10 (1.81)
Gray Whale – Western North Pacific Population	1 (0.35)
North Pacific Right Whale	1 (0.06)
Sperm Whale	22 (0.02)
Spotted Seal – Southern DPS	1 (0.02)

WNP=Western North Pacific
*Although North Pacific right whale and Western North Pacific gray whales potentially occur in the East China Sea mission are in the fall through spring seasons, because the Navy modeled and presented take estimates for the summer season in this mission area when neither species occurs, the Navy did not provide take estimates for either the North Pacific right and Western North Pacific gray whales in the East China Sea mission area. However, because these species are known to occur in low densities in the waters of this mission area during seasons that were not modeled (i.e., fall through spring), we estimate one take of each of these species will occur in this mission area.

Table 34. Estimated Level B Harassment for Mission Area 7, South China Sea.

South China Sea – Mission Area 7 **1 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Fin Whale	2 (0.02)
Humpback Whale – WNP DPS	2 (0.18)
North Pacific Right Whale	1 (0.04)
Gray Whale – WNP Population	1 (0.04)
Sperm Whale	16 (0.02)

WNP=Western North Pacific

Table 35. Estimated Level B Harassment for Mission Area 8, Offshore Japan 25 to 40° North.

Offshore Japan 25 to 40° North – Mission Area 8 **1 Missions**	
Species	**Take Estimates Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	1 (<0.01)
Fin Whale	1 (<0.01)
Humpback Whale – WNP DPS	1 (0.06)
Sei Whale	4 (0.05)
Sperm Whale	36 (0.03)
Hawaiian Monk Seal	2 (0.12)

WNP=Western North Pacific

Table 36. Estimated Level B Harassment for Mission Area 9, Offshore Japan 10 to 25° North.

Offshore Japan 10 to 25° North – Mission Area 9 **1 Missions**	
Species	**Take Estimates Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	1 (<0.01)
Fin Whale	1 (<0.01)
Humpback Whale – WNP DPS	15 (1.36)
Sei Whale	115 (1.63)
Sperm Whale	34 (0.03)

WNP=Western North Pacific

Table 37. Estimated Level B Harassment for Mission Area 11, Hawaii North.

Hawaii North – Mission Area 10 **1 Missions**	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (0.86)
False Killer Whale – MHI Insular DPS	2 (1.02)

Fin Whale	2 (0.80)
Sei Whale	4 (0.78)
Sperm Whale	27 (0.57)
Hawaiian Monk Seal	14 (0.95)

MHI=Main Hawaiian Islands

Table 38. Estimated Level B Harassment for Mission Area 11, Hawaii South.

Hawaii South – Mission Area 11 1 Missions	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	2 (1.31)
False Killer Whale – MHI Insular DPS	5 (2.68)
Fin Whale	2 (1.21)
Sei Whale	5 (1.22)
Sperm Whale	18 (0.39)
Hawaiian Monk Seal	1 (0.05)

MHI=Main Hawaiian Islands

Table 39. Estimated Level B Harassment for Mission Area 12, Arabian Sea.

Arabian Sea – Mission Area 12 0.5 Missions	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	1 (0.01)
Fin Whale	8 (0.43)
Humpback Whale – Arabian Sea DPS	1 (0.33)
Sperm Whale	73 (0.29)

Table 40. Estimated Level B Harassment for Mission Area 13, Andaman Sea.

Andaman Sea – Mission Area 13 1 Missions

Species	Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)
Blue Whale	1 (0.01)
Fin Whale	1 (<0.01)
Sperm Whale	11 (0.04)

Table 41. Estimated Level B Harassment for Mission Area 14, Northwest Australia.

Northwest Australia – Mission Area 14 0.5 Missions	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	1 (0.03)
Fin Whale	15 (0.04)
Sei Whale	1 (<0.01)
Sperm Whale	9 (0.03)

Table 42. Estimated Level B Harassment for Mission Area 15, Northeast of Japan.

Northeast of Japan – Mission Area 15 0.5 Missions	
Species	**Take Estimates by Level B Harassment – Number of Animals (Total Percent of Stock or DPS)**
Blue Whale	0 (0)
Fin Whale	114 (1.23)
Humpback Whale – WNP DPS	27 (2.53)
Gray Whale – WNP Population	1 (0.02)
North Pacific Right Whale	11 (1.13)
Sei Whale	312 (4.45)
Sperm Whale	73 (0.07)
Steller Sea Lion – Western DPS	2 (<0.01)

WNP=Western North Pacific

2.2 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 CFR §402.02). The action area for this consultation includes areas within the Pacific, Indian, and Atlantic Oceans, and the Mediterranean Sea where the Navy may use SURTASS LFA sonar, and any areas where sound from SURTASS LFA sonar may propagate. The action area also includes transit corridors between ports and areas where SURTASS LFA sonar may operate.

The proposed action contemplates that the Navy could conduct LFA sonar missions in any of the following operational mission areas:

- East of Japan, North Philippine Sea, West Philippine Sea, offshore Guam, Sea of Japan, East China Sea, South China Sea, offshore Japan (25 to 40° North and 10 to 25° North), and northeast of Japan.
- North and south of the Main Hawaiian Islands.
- Western North Atlantic (off Florida and off Norfolk, Virginia), Labrador Sea, eastern North Atlantic, Norwegian Basin, and Mediterranean Sea.
- Arabian Sea, Andaman Sea, northwest Australia, and northeast Australian coast.
- Sea of Okhotsk, Gulf of Alaska, offshore Southern California, and Panama Canal (west approach).

In the first year (through August 2018), the Navy proposes to operate in the following areas:

- East of Japan, North Philippine Sea; West Philippine Sea; offshore Guam; Sea of Japan; East China Sea; South China Sea; offshore Japan (25 to 40° North and 10 to 25° North); and northeast of Japan.
- North and south of the Main Hawaiian Islands.
- Arabian Sea, Andaman Sea, and northwest Australia.

Operation of SURTASS LFA sonar may occur in any marine waters within these areas, except the LFA sonar sound field cannot exceed 180 dB re: 1 µPa (rms): (1) at a distance less than 22 km (12 nmi) from any coastline; and (2) less than one km (0.5 nmi) seaward of the outer perimeter of OBIAs. The SURTASS LFA sonar operations will not occur in polar regions (i.e., Arctic and Antarctic waters) of the world. The Arctic Ocean, the Bering Sea (including Bristol Bay and Norton Sound), portions of the Norwegian, Greenland, and Barents Seas north of 72° North latitude, plus Baffin Bay, Hudson Bay, and the Gulf of St. Lawrence will be non-operational areas for SURTASS LFA sonar operations. In Antarctic waters, south of 60° South latitude, will be non-operational areas for SURTASS LFA sonar operations. The Navy has excluded polar regions from operational area planning due to the inherent inclement weather conditions and the navigational and operational (equipment) danger that icebergs pose to SURTASS LFA sonar vessels.

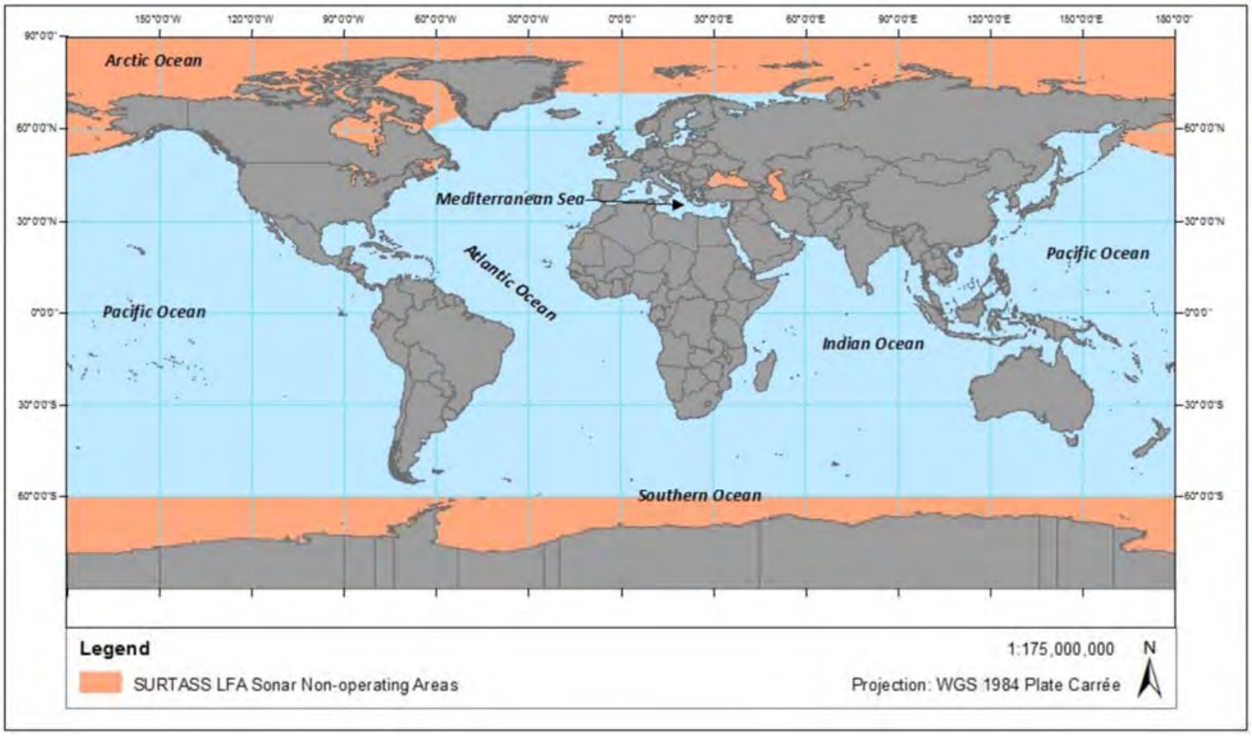

Figure 6. Map of the potential operation areas for the Navy's Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar.

2.3 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. NMFS determined that there are no interrelated or interdependent actions outside the scope of Navy's SURTASS LFA sonar routine training, testing, and military operations and NMFS's proposed promulgation of MMPA regulations and subsequent issuance of letters of authorization pursuant to the MMPA regulation as described in this opinion.

2.4 Summary of the Proposed Action

The Navy proposes to use SURTASS LFA sonar during routine training, testing, and military operations onboard up to four vessels. The purpose of the Navy's proposed action is to meet the United States' need for an improved ability to detect quieter and harder-to-find foreign submarines at long range to provide U.S. forces with adequate time to respond to potential submarine threats (Navy 2012a; Navy 2016; Navy 2017b). This opinion supersedes all previous consultations on similar actions.

Consistent with 50 C.F.R. 402.14(i)(6), this consultation includes an analysis of a framework for the development of future actions (i.e., the mitigation, monitoring, and reporting requirements for the duration of the five year period of the Navy's proposed action) and where sufficient information is available, and an analysis of the likely effects of these future actions on ESA-listed resources. Where sufficient information is available and take is reasonably certain to occur, this consultation includes an incidental take statement (ITS). The take of marine mammals by Level B harassment, as that term is defined in the MMPA, incidental to SURTASS LFA sonar activities may not exceed 12 percent of marine mammal stock.

The Navy can only predict the level and general location (i.e., mission areas) of SURTASS LFA sonar operations for a one-year period into the future. However, these levels and locations have changed minimally since 2002. Based on the Navy's operational history, this consultation assumes that the Navy's SURTASS LFA sonar operations will continue to be used in the mission areas proposed for the period of August 15, 2017 through August 14, 2018 and at levels no higher than those reflected in the Navy's biological evaluation from 2017 through 2022, and into the reasonably foreseeable future. If the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, such a change would require additional consultation under section 7 of the ESA that tiers off of the programmatic analysis in this consultation.

Additionally, NMFS recognizes that while Navy SURTASS LFA sonar routine training, testing, and military operational requirements change over time in response to global or geopolitical events and other factors, the general types of activities addressed by this consultation are expected to continue into the reasonably foreseeable future, along with the associated impacts. Therefore, as part of our effects analysis, we also assumed that the activities proposed for the period of August 15, 2017 through August 14, 2018, and the period of the five-year (2017 through 2022) proposed action would continue into the reasonably foreseeable future at levels and locations similar to that described in this opinion, and we considered the direct and indirect effects of those assumed future activities, together with the effects of all interrelated and interdependent actions. This approach addresses the court decision in *Intertribal Sinkyone Wilderness Council v. National Marine Fisheries Service et al.*, No. 1:12-cv-00420-NJV (N.D. Ca. September 25, 2013), although we may consider a different approach in future actions.

Notwithstanding this analysis, however, NMFS would fully take into account all of the best available science and any change in the status of the species when and if the MMPA compliance regime changes. The Navy may also need to initiate a new ESA section 7 consultation at that time.

3 OVERVIEW OF NATIONAL MARINE FISHERIES SERVICE'S ASSESSMENT FRAMEWORK

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

"To jeopardize the continued existence of an ESA-listed species" 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 CFR §402.02). The jeopardy analysis considers both survival and recovery of the species.

Section 7 assessment involves the following steps:

1) We identify the proposed action and those aspects (or stressors) of the proposed action that are likely to have direct or indirect effects on the physical, chemical, and biotic environment within the action area, including the spatial and temporal extent of those stressors.

2) We identify the ESA-listed species and designated critical habitat that are likely to co-occur with those stressors in space and time.

3) 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.

4) We identify the number, age (or life stage), and gender 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.

5) 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 analyses.

6) 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.

7) The adverse modification analysis considers the impacts of the proposed action on the essential habitat features and conservation value of designated critical habitat.

8) We describe any cumulative effects of the proposed action in the action area.

9) We integrate and synthesize the above factors by considering the effects of the action to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

   a) Reduce appreciably the likelihood of both survival and recovery of the ESA-listed species in the wild by reducing its numbers, reproduction, or distribution; or

b) Reduce the conservation value of designated or proposed critical habitat.

These assessments are made in full consideration of the status of the species and critical habitat.

10) We state our conclusions regarding jeopardy and the destruction or adverse modification of 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, we must identify a reasonable and prudent alternative to the action. The reasonable and prudent alternative must not be likely to jeopardize the continued existence of ESA-listed species nor destroy or adversely modify their designated critical habitat and it must meet other regulatory requirements.

3.1 Evidence Available for the Consultation

In 2002, NMFS Endangered Species Division completed its first consultation on the Navy's proposed employment of the SURTASS LFA sonar system and NMFS Permits, Conservation, and Education Division's proposal to authorize the "take" of marine mammals pursuant to the Navy's employment of the SURTASS LFA sonar system. From 2002 through 2015, inclusive, NMFS completed consultations (and a conference report in 2015 and 2016) on each annual letter of authorization the Permits and Conservation Division issued to the Navy for annual SURTASS LFA sonar missions. Additionally, consultations on new MMPA regulations governing SURTASS LFA sonar operations were completed in 2002, 2007, and in 2012. Thus, this consultation builds upon the earlier work NMFS has done on previous SURTASS LFA sonar operations and uses the evidence we collected, analyzed, and synthesized for those earlier opinions as its foundation.

For this consultation, we identified new lines of evidence on the potential effects of the SURTASS LFA sonar system on endangered species, threatened species, and designated critical habitat. We considered all lines of evidence available through published and unpublished sources that represent evidence of adverse consequences or the absence of such consequences. NMFS' status reviews for ESA-listed species also provide information on the status of the species including their resiliency, population trends, and specific threats to recovery that contributes to our *Status of Endangered Species Act-Listed Resources*, *Environmental Baseline*, and *Effects of the Action* analyses.

To comply with our obligation to use the best scientific and commercial data available, we conducted electronic literature searches throughout the consultation, including within NMFS Office of Protected Resources' electronic library (using *Endnote* ® software). We examined the literature that was cited in the submittal documents and any articles we collected through our electronic searches. The Navy provided NMFS with a draft and final SEIS/SOEIS on SURTASS LFA sonar routine training, testing, and military operations that are proposed in the action area, along with two biological evaluations. We also evaluated the Navy's annual and comprehensive monitoring reports required by the existing five-year MMPA rule and letters of authorization and previous opinions to assess the effectiveness of mitigation and actual take incidental to SURTASS LFA sonar operation levels where feasible. In addition, we engage regularly with the Navy to discuss new science and technical issues as part of the ongoing adaptive management program for the operation of SURTASS LFA sonar.

Considering the information that was available, this consultation and our opinion includes uncertainty about the basic hearing capabilities of some marine mammals, sea turtles, and fishes; how these taxa use sounds as environmental cues; how they perceive acoustic features of their environment; the importance of sound to the normal behavioral and social ecology of species; the mechanisms by which human-generated sounds affect the behavior and physiology (including the non-auditory physiology) of exposed individuals; and the circumstances that are likely to produce outcomes that have adverse consequences for individuals and populations of exposed species.

3.1.1 Approach to Assessing Affects to Marine Mammals

This section gives a brief summary of the Navy's approach to assessing the exposure and response of marine mammals to SURTASS LFA sonar. The Navy used the Acoustic Integration Model$^{©}$ (AIM) to simulate the sound field produced by the SURTASS LFA sonar source operations and determine the potential acoustic impacts to marine mammal species present within the sound field of the SURTASS LFA mission areas considered in this opinion.

The AIM integrates the acoustic field created from the underwater transmissions of LFA sonar with the four-dimensional movement of marine mammals to estimate their potential sonar exposure within a specified modeling period. To predict acoustic exposure, the LFA sonar ship was simulated traveling in a triangular pattern at a speed of 7.4 kph (4 knots), with the time on each bearing (each "leg" of the triangle) being eight hours (480 minutes). The duration of LFA sonar transmissions was modeled as 24 hours at each mission area, with a signal duration of 60 seconds and a duty cycle of ten percent (i.e., the source transmitted for 60 seconds every ten minutes for 24 hours). The acoustic field around the LFA sonar vessel was predicted with the operating parameters of LFA sonar in the Navy standard parabolic equation propagation model. Each marine mammal species potentially occurring in a modeling area was simulated by creating animats programmed with behavioral values describing their dive behavior, including dive depth, surfacing time, dive duration, swimming speed, and direction change. The marine mammal density estimates used in the modeling are presented in section 3.1.1.2. The output of AIM is the time history of exposure for each animat and since AIM records the exposure history for each individual animat, the potential effect is determined on an individual animal basis. The sound energy received by each individual animat over the modeled period was calculated as the sound exposure level (SEL; to assess the potential for PTS and TTS) in decibels, single ping equivalent (dB SPE; to assess the potential risk of a biologically significant behavioral reaction). Additional detail on the criteria used to assess the effects to marine mammals from exposure to SURTASS LFA sonar is below in section 3.1.1.1.

For the five years of proposed use of SURTASS LFA sonar, 26 representative mission areas in the Pacific, Indian, and Atlantic Oceans and the Mediterranean Sea were analyzed to represent the acoustic regimes and marine mammal species that may be encountered during SURTASS LFA sonar operations. In each representative mission area, the potential for PTS, TTS, and behavioral change of marine mammals was estimated based on 24 hours of LFA sonar operations. As for anticipated impacts on an annual basis, the acoustic effects analysis assessed the impacts associated with SURTASS LFA sonar operations in ten mission areas of the western North Pacific Ocean, two mission areas in the central North Pacific Ocean, and three mission areas in the Indian Ocean. The potential for PTS, TTS, and behavioral change was estimated based on 24 hours of LFA sonar operations (similar to the analysis for the rule) in each mission area that was then multiplied by the proposed mission duration, or seven days.

3.1.1.1 Criteria for Assessing Effect to Marine Mammals from SURTASS LFA Sonar

To ensure that each individual is considered for only one potential effect (i.e., there is no double counting), the potential for PTS is considered first, as it represents the highest threshold. If an individual does not exceed the PTS threshold, then the potential for TTS is considered. If an animal does not exceed the TTS threshold, then the potential for a behavioral response is considered. Thus, individuals are not considered for more than one acoustic impact during a 24-hour exposure scenario.

Criteria for Auditory Effects (PTS and TTS)

In 2016, NMFS issued guidance (*Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* [NOAA Technical Memorandum NMFS-OPR-55]) on assessing the auditory effects of anthropogenic sound on marine mammals. Specifically, NMFS' acoustic guidance identifies the received levels, or acoustic threshold levels, above which individual marine mammals are predicted to experience changes in their hearing sensitivity (PTS or TTS). These thresholds were implemented in the quantitative analysis of effects of SURTASS LFA sonar on marine mammals. Further detail on the guidance is available in NOAA Technical Memorandum NMFS-OPR-55 (NOAA 2016b).

Recognizing that marine mammal species do not have equal hearing capabilities, the guidance defined five functional hearing groups of marine mammals:

- Low-frequency Cetaceans – this group consists of the mysticetes with a collective generalized hearing range of 7 Hz to 35 kHz.
- Mid-frequency Cetaceans – includes most of the dolphins, all toothed whales except for *Kogia* spp., and all the beaked and bottlenose whales with a generalized hearing range of approximately 150 Hz to 160 kHz.
- High-frequency Cetaceans – incorporates all the true porpoises, the river dolphins, plus *Kogia* spp., *Cephalorhynchus* spp. (genus in the dolphin family Delphinidae), and two

species of *Lagenorhynchus* (Peale's and hourglass dolphins) with a generalized hearing range estimated from 275 Hz to 160 kHz.
- Phocids Underwater – consists of true seals with a generalized underwater hearing range from 50 Hz to 86 kHz.
- Otariids Underwater – includes sea lions and fur seals with a generalized underwater hearing range from 60 Hz to 39 kHz.

Within their generalized hearing ranges, the ability to hear sounds varies with frequency, as demonstrated by examining audiograms of hearing sensitivity (Finneran 2015; NOAA 2016b) . To reflect higher noise sensitivities at particular frequencies, auditory weighting functions were developed for each functional hearing group that reflected the best available data on hearing ability (composite audiograms), susceptibility to noise-induced hearing loss, impacts of noise on hearing, and data on equal latency. These weighting functions are applied to individual sound received levels to reflect the hearing ability of each species to process received acoustic energy.

SURTASS LFA sonar is a non-impulsive source in that its signals do not have the high peak pressure with rapid rise time and decay that impulsive sounds do; instead, the pressure (i.e., intensity) of the LFA sonar transmission is consistent throughout the signal. The acoustic threshold levels for non-impulsive sounds are defined as the cumulative sound exposure level (SEL) over a 24-hour period with the appropriate frequency weighting for each functional hearing group, which is reflected in the subscript of each threshold (e.g., the low frequency cetacean threshold is identified as $L_{E,LF,24h}$, where $L_{E,\ LF,\ 24h}$ = low frequency sound exposure level cumulated over 24 hour). The cumulative SEL metric takes into account both received level and duration of exposure over the duration of the activity within a 24-hour period. The TTS threshold is defined as 20 dB less than the PTS threshold. A summary of the cumulative sound exposure acoustic thresholds for PTS and TTS that were used in this analysis are provided in Table 43.

Table 43. Acoustic threshold levels for marine mammals exposed to non-impulsive sounds (NOAA 2016b).

Hearing Group	Permanent Threshold Shift Onset	Temporary Threshold Shift Onset
Low-frequency Cetaceans (LE,LF,24 hour)	199 dB SEL	179 dB SEL
Mid-frequency Cetaceans (LE,MF,24 Hour)	198 dB SEL	178 dB SEL
High-frequency Cetaceans (LE,HF,24 Hour)	173 dB SEL	153 dB SEL
Phocid Pinnipeds Underwater (LE,PW,24 Hour)	201 dB SEL	181 dB SEL
Otariid Pinnipeds Underwater (LE,OW,24 Hour)	219 dB SEL	199 dB SEL

LE, X, 24 Hour=Frequency Sound Exposure Level (SEL) Cumulated over 24 Hour
LF=Low-Frequency
MF=Mid-Frequency
HF=High-Frequency
PW=Phocids Underwater
OW=Otariids Underwater

Assessing the Potential for Behavioral Response

The Low Frequency Sound Scientific Research Program (LFS SRP) in 1997 through 1998 provided important results on, and insights into the responses of baleen whales when exposed to SURTASS LFA sonar signals and the way those responses scaled relative to received level and context. The LFS SRP experiments continue to represent the most relevant predictions of the potential for behavioral changes from exposure to LFA sonar. The results of the LFS SRP confirmed that some portion of the total number of whales exposed to LFA sonar responded behaviorally by changing their vocal activity, moving away from the source vessel, or both; but the responses were short-lived and animals returned to their normal activities within tens of minutes after initial exposure (Clark and Fristrup 2001a). Perhaps the most important result came from the LFS SRP Phase II study, where the LFA sonar stimulus was presented to migrating gray whales. When the source was in the migratory path, the whales diverted around the source at received levels of 170 to 178 dB re: 1 μPa (rms). However, when the source was moved offshore to the edge of the migratory corridor, with an increased source level to maintain the same received levels at the whales, the migrating gray whales exhibited no response to the LFA stimulus (Clark 1999). The context of an exposure scenario is clearly important for determining the probability, magnitude, and duration of a response (Ellison et al. 2012b).

The results of the LFS SRP were used to derive the LFA risk continuum function, from which the potential for biologically significant behavioral response is calculated as described in the impact analysis section below. This function has been described in detail in previous Navy documentation for SURTASS LFA sonar (Navy 2001a; Navy 2001b; Navy 2007; Navy 2012a; Navy 2017b), which as previously noted are incorporated by reference. The risk continuum is based on the premise that a smooth, continuous function that maps received level to risk is most appropriate for defining the potential or risk for a biologically significant behavioral response (Figure 5-3). A summary of the risk continuum function follows; the reader is referred to the 2012 or 2017 SURTASS LFA sonar environmental impact statements for additional details (Navy 2012a; Navy 2017b).

The parameters of the risk continuum function are based on the LFS SRP results. These experiments, which exposed baleen whales to received levels ranging from 120 to about 155 dB re: 1 μPa (rms) (SPL), detected only minor, short-term behavioral responses. Short-term behavioral responses do not necessarily constitute significant changes in biologically important behaviors. The fact that none of the LFS SRP observations revealed a significant change in a biologically important behavior helped determine an upper bound for risk. However, the LFS SRP results cannot be used to prove that there is zero risk at these levels. Accordingly, the risk continuum assumes that risk is small, but not zero, at the received levels achieved during the LFS SRP. The basement value below which risk is negligible is 120 dB single ping equivalent (SPE). Fifty percent risk of a behavioral response is defined at 165 dB SPE. The steepness of the curve, termed the risk-transition-sharpness-parameter, is defined as 10 for LFA sonar.

The risk continuum modeled a smooth increase in risk that culminates in a 95 percent level of risk of significant change in a biologically important behavior at 180 dB SPE. In this region, the risk continuum is unsupported by observations. Since the risk continuum function was derived from the behavioral response data of baleen whales collected with an actual SURTASS LFA sonar source, these data are realistic contextually and remain the best available for the response of low frequency-sensitive marine mammals to the SURTASS LFA sonar source.

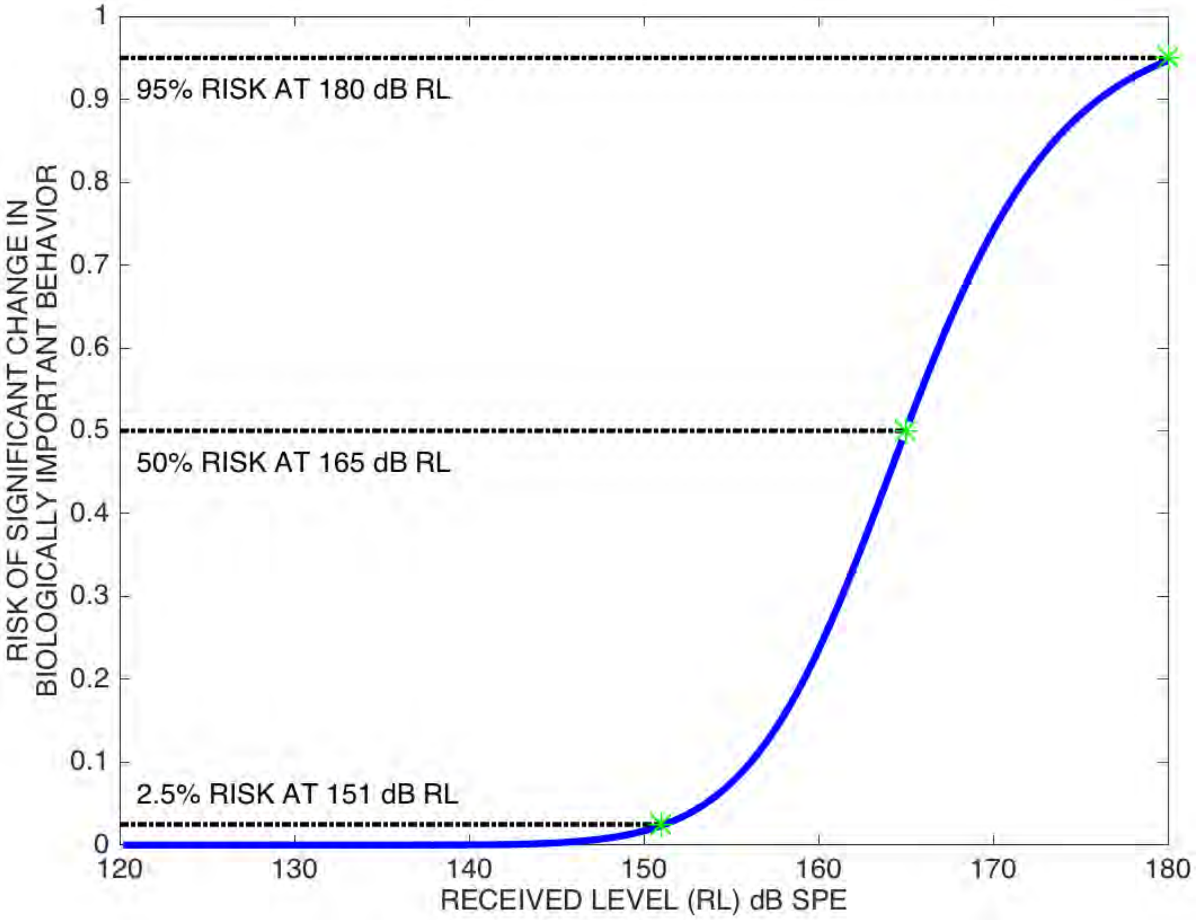

Figure 7. Risk continuum function for Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar that related the risk of significant change in biologically important behavior to received levels in decibels, single ping equivalent (SPE).

The Navy uses the risk continuum function for SURTASS LFA sonar to quantify the number of behavioral responses that could qualify as Level B (behavioral) harassment under the MMPA. As the statutory definition is currently applied, a wide range of behavioral reactions may qualify as

Level B harassment under the MMPA, including but not limited to avoidance of the sound source, temporary changes in vocalizations or dive patterns, temporary avoidance of an area, or temporary disruption of feeding, migrating, or reproductive behaviors. The estimates calculated using the risk continuum function do not differentiate between the different types of potential reactions nor the significance of those potential reactions. These estimates also do not provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. Therefore, our analysis considers the available scientific evidence to determine the likely nature of modeled behavioral responses and potential fitness consequences for affected individuals.

3.1.1.2 Occurrence and Population Estimates of Marine Mammals

Although the distribution of many marine mammal species is irregular and highly dependent upon geography, oceanography, and seasonality, density and abundance estimates for each marine mammal species occurring in an activity area are critical components of the analytical estimation methodology to assess risk to marine mammal populations from activities occurring in the marine environment. Marine mammal species or DPSs were identified and population estimates (abundance and density estimates) were derived for each species at each representative mission area for a selected season. The ESA-listed marine mammal species occurring at each representative mission area were verified with distributional information and data from published literature; government reports, including NMFS' stock assessment reports for U.S. waters and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.

The process for developing density and abundance estimates for every ESA-listed marine mammal species possibly occurring in the representative mission areas was a multi-step procedure that first utilized data with the highest degree of fidelity. Abundance estimates are typically more available than are density estimates, which require more sophisticated sampling and analysis and are not always available for each species or DPS in all mission areas. In cases where no abundance estimates were available for a species or DPS, abundance estimates derived for another population of the same species or a similar species in a similar oceanographic province were used as surrogate abundances. These population data were derived using the best available information and data (see the following for additional detail: Navy (2017b), Navy (2016), and Navy (2017c)), including the most current NMFS stock assessment reports for U.S. North Pacific, Alaska, and Atlantic waters (Carretta et al. 2017; Hayes et al. 2017; Muto et al. 2017), respectively, or the stock assessment report that was relevant for a species' or DPS's information.

Density estimates require more sophisticated sampling and analysis and were not always available for each species at all sites. Density estimates were derived by first using direct estimates from line-transect surveys that occurred in or near each of the 26 mission areas (Barlow 2006). When density estimates were not available from a survey in a representative mission area, density estimates from a region with similar oceanographic characteristics were extrapolated to the mission area. For example, the waters of the eastern tropical Pacific have been extensively surveyed for marine mammals, resulting in a comprehensive understanding of marine mammal distribution and population estimation in subtropical and tropical oceanic waters (Ferguson et al. 2003; Ferguson and Barlow 2001; Wade and Gerrodette 1993). These estimates provided the basis for density estimates in similar geographic areas where population data were lacking. Densities for some mission areas/model sites were also derived from the Navy's Marine Species Density Database (Navy 2016; Navy 2017b; Navy 2017c), which is based on a variety of scientific literature, data, and habitat spatial modeling. Last, density estimates are usually not available for rare marine mammal species or for those that have been more recently defined (e.g., the North Pacific right whale). For such species, the lowest density estimate of 0.0001 animals per square kilometer (animals/km^2) was used in the risk analysis for SURTASS LFA sonar to reflect the low probability of occurrence in a specific SURTASS LFA sonar mission area.

Marine mammal abundance and density estimates used in the acoustic exposure analysis for each mission area are presented in Table 44. Marine mammal distribution varies by season. For the exposure estimates provided in section 2.1.7, due to the large number of potential mission areas and seasons to be considered in the impact analysis, a seasonal sensitivity study was conducted to determine the optimal modeling season for each mission area. The modeling season was chosen based on an analysis of the sound velocity profiles, resulting sound propagation and transmission loss fields, with the season for which the longest-range acoustic propagation was estimated typically being selected. For the exposure estimates provided in the proposed letter of authorization (i.e., a specified number of missions in a subset of the mission areas analyzed for the rule), when multiple missions were proposed in a mission area, a second and third season (depending on the number of missions) were selected that provided the next best acoustic propagation environments.

Table 44. Estimated abundance and density of each ESA-listed marine mammal stock or DPS that may be affected by the operation of SURTASS LFA sonar at received levels of 120 to 180 dB SPL, in 26 potential mission areas during the five-year proposed action.

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
East of Japan – Summer			
Blue Whale	WNP	9,250	0[1]
Fin Whale	WNP	9,250	0.0002
Humpback Whale	WNP DPS	1,059	0.00036
North Pacific Right Whale	WNP	922	0[1]
Sei Whale	NP	7,000	0.006
Sperm Whale	NP	102,112	0.00123
North Philippine Sea – Fall			

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Blue Whale	WNP	9,250	0.00001
Fin Whale	WNP	9,250	0[1]
Humpback Whale	WNP DPS	1,059	0.00089
North Pacific Right Whale	WNP	922	0[1]
Sperm Whale	NP	102,112	0.00123
West Philippine Sea – Fall			
Blue Whale	WNP	9,250	0.00001
Fin Whale	WNP	9,250	0[1]
Humpback Whale	WNP DPS	1,059	0.00089
Sperm Whale	NP	102,112	0.000123
Offshore Guam – Summer			
Blue Whale	WNP	9,250	0[1]
Fin Whale	WNP	9,250	0[1]
Humpback Whale	WNP DPS	1,059	0[1]
Sei Whale	NP	7,000	0[1]
Sperm Whale	NP	102,112	0.00123
Sea of Japan – Fall			
Fin Whale	WNP	9,250	0.0009
Gray Whale	WNP	140	0.00001
North Pacific Right Whale	WNP	922	0[1]
Sperm Whale	NP	102,112	0.00123
Spotted Seal	Southern DPS	3,500	0.00001
East China Sea – Summer			
Fin Whale	ECS	500	0.0002
Gray Whale	WNP	140	0[1]
North Pacific Right Whale	WNP	922	0[1]
Sperm Whale	NP	102,112	0.00123
Spotted Seal	Southern DPS	1,000	0.00001
South China Sea – Fall			

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Fin Whale	WNP	9,250	0.0002
Gray Whale	WNP	140	0.00001
Humpback Whale	WNP DPS	1,059	0.00036
North Pacific Right Whale	WNP	922	0[1]
Sperm Whale	NP	102,112	0.0012
Offshore Japan (25 to 40° North) – Summer			
Blue Whale	WNP	9,250	0[1]
Fin Whale	WNP	9,250	0.0001
Humpback Whale	WNP	1,059	0.00036
Sei Whale	NP	7,000	0.00029
Sperm Whale	NP	102,112	0.0022
Hawaiian Monk Seal	Hawaiian	1,400	0.00001
Offshore Japan (10 to 25° North) – Winter			
Blue Whale	WNP	9,250	0.00001
Fin Whale	WNP	9,250	0.00001
Humpback Whale	WNP DPS	1,059	0.00036
Sei Whale	NP	7,000	0.0029
Sperm Whale	NP	102,112	0.0029
Hawaii North – Summer			
Blue Whale	CNP – Hawaii	133	0[1]
False Killer Whale	MHI Insular DPS	151	0.000796
Fin Whale	Hawaii	154	0[1]
Sei Whale	Hawaii	391	0[1]
Sperm Whale	Hawaii	4,559	0.00158
Hawaiian Monk Seal	Hawaii	1,400	0.000723
Hawaii South – Fall			
Blue Whale	CNP – Hawaii	133	0.00005
False Killer Whale	MHI Insular DPS	151	0.000796
Fin Whale	Hawaii	154	0.00006
Sei Whale	Hawaii	391	0.00016

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Sperm Whale	Hawaii	4,559	0.00131
Hawaiian Monk Seal	Hawaii	1,400	0.00003
Offshore Southern California – Spring			
Blue Whale	ENP	1,647	0.00011
Fin Whale	C/O/W	19,029	0.00022
Gray Whale	WNP	140	0.00001
Humpback Whale	Mexico DPS	4,041 – C/O/W Stock 3,264 – Mexico DPS	0.00121
Humpback Whale	Central America DPS	4,041 – C/O/W Stock 411 – Central America DPS	0.00121
Sei Whale	ENP	519	0.00009
Sperm Whale	C/O/W	2,106	0.00337
Guadalupe Fur Seal	Mexico	15,830	0.00387
Western North Atlantic (Off Florida) – Winter			
North Atlantic Right Whale	WNA	524	0.00002
Sperm Whale	WNA	2,288	0.00083
Eastern North Atlantic – Summer			
Blue Whale	ENA	979	0.00002
Fin Whale	ENA	9,019	0.001
Humpback Whale	Cape Verdes Islands/Northwest Africa DPS	10,752 – Iceland Stock or West Indies DPS 88 – Cape Verdes/Northwest Africa DPS	0.00009
Sei Whale	Iceland-Denmark Strait	10,300	0.0004
Sperm Whale	ENA	7,785	0.00077
Mediterranean Sea – Summer			
Fin Whale	Mediterranean	3,583	0.00168
Sperm Whale	WM	396	0.0052
Arabian Sea – Summer			

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Blue Whale	North Indian	3,432	0.00004
Fin Whale	Indian	1,716	0.00092
Humpback Whale	Arabian Sea DPS	82	0.00005
Sperm Whale	North Indian	24,446	0.00877
Andaman Sea – Summer			
Blue Whale	North Indian	3,432	0.00003
Fin Whale	Indian	1,716	0[1]
Sperm Whale	North Indian	24,446	0.00107
Panama Canal – Winter			
Blue Whale	ENP	1,647	0.00008
Fin Whale	ENP	832	0[1]
Humpback Whale	Central America DPS	411	0.00001
Sperm Whale	ETP	22,700	0.0047
Northeast Australia – Spring			
Blue Whale	WSP	9,250	0.00001
Fin Whale	WSP	9,250	0.0002
Sei Whale	WSP	7,000	0.0006
Sperm Whale	WSP	102,112	0.00123
Northwest of Australia – Winter			
Blue Whale	South Indian	1,657	0[1]
Fin Whale	South Indian	38,185	0.00001
Sei Whale	Indian	13,854	0.00001
Sperm Whale	South Indian	24,446	0.00096
Northeast of Japan – Summer			
Blue Whale	WNP	9,250	0[1]
Fin Whale	WNP	9,250	0.0002
Gray Whale	WNP	140	0.00001
Humpback Whale	WNP DPS	1,059	0.0005
North Pacific Right Whale	WNP	922	0.00001
Sei Whale	NP Pelagic	7,000	0.00029

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Sperm Whale	NP	102,112	0.0022
Steller Sea Lion	Western DPS	69,704	0.00001
Southern Gulf of Alaska – Summer			
Blue Whale	ENP	1,647	0.00051
Fin Whale	AK/NEP	1,368	0.00049
Humpback Whale	WNP DPS	8,226 – Humpback Whales in Southern Gulf of Alaska Mission Area 1,059 – WNP DPS	0.0005
Humpback Whale	Mexico DPS	8,226 – Humpback Whales in Southern Gulf of Alaska Mission Area 3,264 – Mexico DPS	0.0005
North Pacific Right Whale	ENP	31	0.00003
Sei Whale	ENP	126	0.00007
Sperm Whale	NP	102,112	0.00127
Steller Sea Lion	Western DPS	50,983	0.01085
Southern Norwegian Basin – Summer			
Blue Whale	ENA	979	0.00001
Fin Whale	Northwest Norway	6,409	0.00157
Humpback Whale	Cape Verdes Islands/West Africa DPS	10,752 – West Indies DPS 88 – Cape Verdes Islands/West Africa DPS	0.00009
Sei Whale	Iceland-Denmark Strait	10,300	0.00001
Sperm Whale	ENA	7,785	0.0049
Western North Atlantic (Off Virginia) – Summer			
Fin Whale	WNA	1,618	0.00075
North Atlantic Right Whale	WNA	524	0.0000

Species by Mission Area	Marine Mammal Stock or DPS	Estimated Number in Stock or DPS	Density Estimates (Animals/km^2)
Sperm Whale	WNA	2,288	0.01274
Labrador Sea – Winter			
Blue Whale	WNA	440	0.00002
Fin Whale	Canadian East Coast	1,352	0.00005
North Atlantic Right Whale	WNA	524	0.0000
Sei Whale	Labrador Sea	965	0.00002
Sperm Whale	WNA	2,288	0.00127
Ringed Seal	Arctic DPS	787,000	0.07300
Sea of Okhotsk – Spring			
Bowhead Whale	Okhotsk Sea	247	0.00001
Fin Whale	WNP	9,250	0.0002
Gray Whale	WNP	140	0[1]
Humpback Whale	WNP DPS	1,059	0.00089
North Pacific Right Whale	WNP	922	0[1]
Sperm Whale	NP	102,112	0.0022
Bearded Seal	Okhotsk DPS	200,000	0.01174
Ringed Seal	Okhotsk DPS	676,000	0.23881
Steller Sea Lion	Western DPS	82,516	0.02189

[1] Species is not expected in the mission area that season.

WNP=Western North Pacific
CNP=Central North Pacific
NP=North Pacific
ECS=East China Sea
MHI=Main Hawaiian Islands
C/O/W=California/Oregon/Washington
WAU=West Australia
ENP=Eastern North Pacific
WNA=Western North Atlantic
ENA=Eastern North Atlantic
WM=Western Mediterranean
ETP=Eastern Tropical Pacific
WSP=Western South Pacific
AK=Alaska
NEP=Northeastern Pacific

3.1.2 Approach to Assessing Effects to Sea Turtles

The Navy did not use AIM to assess the exposure and response of sea turtles to SURTASS LFA sonar because such an analysis would require adequate information on the distribution and density of sea turtles species in the open ocean and this information is not currently available. The best available population estimates (abundances) for all sea turtle species are typically underestimates as they nearly always are nesting counts of females when they come ashore to nest and lay their eggs. Some nearshore foraging hotspots having been identified for loggerhead turtles (Seminoff et al. 2014). Additionally, nearshore breeding aggregations have been identified for some species (i.e., olive ridley). However, the density of turtles observed in these locations is very different from what would be expected in the open ocean environments where SURTASS LFA sonar will operate. Nearly all species of sea turtles occur in low numbers over most of their ranges, resulting in widely dispersed and variable distributions in the open ocean. Coupled with low numbers dispersed over enormous geographic areas is the additional complexity of some sea turtle's lifestages, such as the leatherback and olive ridley turtles, which spend their entire lives dispersed widely in pelagic waters, while the early lifestages of other sea turtle species spend only the "lost years" drifting around the central ocean gyres. For these reasons, NMFS and the Navy were unable to provide sea turtle density estimates to use in the exposure analyses and we are unable to estimate the number of sea turtle exposed to, and potentially affected by, the operation of SURTASS LFA sonar, which is used to estimate take.

However, we can use available information on the effectiveness of the mitigation proposed during operation of SURTASS LFA sonar to minimize adverse effects to sea turtles, sea turtle densities in the open ocean environment, how sea turtles use underwater sound, and how sea turtles respond to sound exposures to assess the likely effects of the operation of SURTASS LFA sonar on ESA-listed sea turtles. This analysis is presented in sections 7.4 and 7.6 of this opinion.

3.2 Defining "Significance"

In opinions, we focus on potential physical, chemical, or biotic stressors that are "significant" in the sense of being distinct from ambient or background aspects of the environment. We then ask if:

(a) Exposing individuals to those potential stressors is likely to represent a "significant" negative experience in the life history of individuals that have been exposed; and if

(b) Exposing individuals to those potential stressors is likely to cause the individuals to experience "significant" physical, chemical, or biotic responses; and if

(c) Any "significant" physical, chemical, or biotic response are likely to have "significant" consequence for the fitness of the individual animal and relevant populations; and if

(d) Exposing the physical, chemical, or biotic phenomena that we identified as constituent elements in a critical habitat designation or, in the case of critical habitat designations that do not identify constituent elements, those physical, chemical or biotic phenomena that give designated critical habitat value for the conservation of endangered or threatened species is likely to represent a "significant" change in the quantity, quality, or availability of the physical, chemical, or biotic resource; and if

(e) Any "significant" change in the quantity, quality, or availability of a physical, chemical, or biotic resource is likely to "significantly" reduce the conservation value of the designated critical habitat.

In all of these cases, the term "significant" means "clinically or biotically significant" rather than statistically significant because the present or absence of statistical significance do not imply the presence or absence of clinical significance (Achinstein 2001; Royall 2004).

For populations (or sub-populations), we are concerned about whether the number of individuals that are likely to experience "significant" reductions in fitness and the nature of any fitness reductions are likely to have a "significant" consequence for the viability (equals probability of demographic, ecological, or genetic extinction) of the population(s) those individuals represent. Here "significant" also means "clinically or biotically significant" rather than statistically significant.

For "species" (the entity that has been ESA-listed as endangered or threatened, not the biological species concept), we are concerned about whether the number of populations that are likely to experience "significant" reductions in viability and the nature of any reductions in viability (equals increases in their extinction probabilities) and the nature of any reductions in viability are likely to have "significant" consequence for the viability (equals probability of demographic, ecological, or genetic extinction) of the "species" those population comprise. Here, again, "significant" also means "clinically or biotically significant" rather than statistically significant.

For designated critical habitat, we are concerned about whether the area that has been designated is likely to experience "significant" reductions in the quantity, quality, or availability of physical, chemical, or biotic resources that are likely to result in "significant" reduction in the conservation value (usually measured using the concept of carrying capacity) of the entire area contained in the designation.

3.3 Treatment of "Cumulative Impacts"

The Council on Environmental Quality defined "cumulative impacts" as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR §1508.7). The effects analyses of ESA opinions consider the "impacts" on ESA-listed species and designated critical habitat that result from the incremental impact of an action by identifying natural and anthropogenic stressors that affect endangered and threatened species throughout their range (the *Status of Endangered Species Act-Listed Resources*) and within an action area (the *Environmental Baseline*, which articulate the pre-existing impacts of activities that occur in an action area, including the past, contemporaneous, and future impacts of those activities). We assess the effects of a proposed action by adding their direct and indirect effects to the impacts of the activities we identify in an *Environmental Baseline* (50 CFR §402.02), in light of the impacts of the status of the ESA-listed species and designated critical habitat throughout their range; as a result, the results of our effects analyses are equivalent to those contained in the "cumulative impact" sections of NEPA documents.

We considered cumulative impacts as part of our consultation. Specifically, we considered (1) stressors that accumulate in the environment, and (2) effects that represent either the response of individuals, populations, or species to that accumulation of stressors. Further, we considered the likely impacts of these accumulative phenomena on an annual basis, over the duration of the five-year proposed action, and under the assumption that these activities would continue into the reasonably foreseeable future. Given the ongoing nature of the proposed activities, we assume that the type, amount, and extent of SURTASS LFA sonar routine training, testing, and military operations do not exceed maximum levels assessed in the action.

In considering accumulating stressors, which captures the normal usage of "cumulative impacts," we concluded that phenomena like sound and ship strike do not accumulate in the environment (sound energy rapidly transforms into other forms of energy and ship strikes are independent, transient events), while, conversely, concentrations of toxic chemicals, sediment, and other pollutants accumulate in the environment.

Assessing the response effects of individuals, populations, or species to the accumulation of stressors, we considered phenomena that accumulate in individuals and individually contribute or collectively determine the probable fitness of the individuals that comprise a population. These include, the passage of time and its corollary, the passage or loss of time (specifically, the loss of time to reproduce, forage, migrate, or conduct other biologically important activities); reproductive success; longevity; energy debit, including allostatic loading (wear and tear on the body from repeated chronic stress); body burdens of toxic chemicals; the fitness costs of behavioral decisions; injuries and tissue damage; and overstimulation of sensory organs (which would include noise-induced losses of hearing sensitivity).

At the level of populations, phemonena that "accumulate" include population abundance; the number or percent of individuals in a population with lifetime reproductive success greater than 2.0; the number or percent of individuals in a population with lifetime reproductive success equal to 2.0 ; the number or percent of individuals in a population with lifetime reproductive success less than 2.0; the number or percent of individuals that immigrate or emigrate from a population per unit time; mortality within a particular age or stage over generation time; and the reservoir of juveniles in a population that have a high probability of surviving to the age of reproduction (population momentum or its absence).

At the species level, when feasible, we accumulate those phenomena that allow us to estimate the extinction risks facing a species. These include increases or decreases in the number of occurrence or populations; the extinction probability of particular occurrences; variances in the rates of population growth or decline; and demographic stochasticity.

Cumulative effects also include effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area and were considered in this opinion. Future Federal actions that are unrelated to the action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

4 ENDANGERED SPECIES ACT-LISTED SPECIES AND CRITICAL HABITAT NOT LIKELY TO BE ADVERSELY AFFECTED

This section identifies the ESA-listed species under NMFS jurisdiction that may occur within the action area (as described in section 2.2) that are not likely to be adversely affected by the proposed action. NMFS uses two criteria to identify the ESA-listed or designated 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 46 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 an ESA-listed species), but it is very unlikely to occur.

In this section, we evaluate effects to several ESA-listed species and designated critical habitat that may be affected, but are not likely to be adversely affected, by the proposed action. For the ESA-listed species, we focus on specifically on stressors associated with Navy's operation of SURTASS LFA sonar and their effects on these species. The effects of other stressors associated with the proposed action, which are also not likely to adversely affect ESA-listed species, are evaluated in section 7.1. The species potentially occurring within the action area that may be affected, but are not likely to be adversely affected, are listed in Table 45, along with their regulatory status, designated critical habitat, and recovery plan.

Table 45. Threatened and endangered species potentially occurring in the action area that may be affected, but are not likely to be adversely affected.

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Marine Mammals – Cetaceans				
Indo-Pacific (Taiwanese) Humpback Dolphin (*Sousa chinensis taiwanensis*)	PE – 82 FR 28802	-- --	-- --	NLAA/NLAA
Maui's Dolphin (*Cephalorhynchus hectori maui*)	PE – 81 FR 64110	-- --	-- --	NLAA/NLAA
Fishes				
African Coelacanth (*Latimeria chalumnae*) – Tanzania DPS	T – 81 FR 17398	-- --	-- --	NLAA/NLAA
Pacific Eulachon (*Thaleichthys pacificus*) – Southern DPS	T – 75 FR 13012	76 FR 65323	10/2016 – Draft 81 FR 72572	NLAA/NLAA
Gulf Grouper (*Mycteroperca jordani*)	E – 81 FR 72545	-- --	-- --	NLAA/NLAA
Island Grouper (*Mycteroperca fusca*)	T – 81 FR 72545	-- --	-- --	NLAA/NLAA
Nassau Grouper (*Epinephelus striatus*)	T – 81 FR 42268	-- --	-- --	NLAA/NLAA
Blackchin Guitarfish (*Rhinobatos cemiculus*)	T – 82 FR 6309	-- --	-- --	NLAA/NLAA
Brazilian Guitarfish (*Rhinobatos horkelli*)	E – 81 FR 21722	-- --	-- --	NE/NLAA
Common Guitarfish (*Rhinobatos rhiobatos*)	T – 82 FR 6309	-- --	-- --	NLAA/NLAA
Giant Manta Ray (*Manta birostris*)	PT – 82 FR 3694	-- --	-- --	NE/NLAA
Atlantic Salmon (*Salmo salar*) – Gulf of Maine DPS	E – 65 FR 69459 74 FR 29344	74 FR 29300	12/2005 70 FR 75473 03/2016 – Draft 81 FR 18639	NLAA/NLAA

Species	**ESA Status**	**Critical Habitat**	**Recovery Plan**	**Navy/NMFS Determination**
Chinook Salmon (*Oncorhynchus tshawytscha*) - California Coastal ESU - Central Valley Spring-Run ESU - Lower Columbia River ESU - Upper Columbia River Spring-Run ESU - Puget Sound ESU - Sacramento River Winter-Run ESU - Snake River Fall-Run ESU - Snake River Spring/Summer-Run ESU - Upper Willamette River Spring-Run ESU	T – 70 FR 37160 T – 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160 T - 70 FR 37160	70 FR 52488 70 FR 52488 70 FR 52630 70 FR 52630 70 FR 52630 58 FR 33212 58 FR 68543 64 FR 57399 70 FR 52630	2016 81 FR 70666 California Coastal ESU 07/2014 79 FR 42504 Central Valley Spring-Run ESU 06/2013 78 FR 41911 Lower Columbia River ESU 08/2007 72 FR 57303 Upper Columbia River Spring-Run ESU 01/2007 72 FR 2493 Puget Sound ESU 07/2014 79 FR 42504 Sacramento River Winter-Run ESU 09/2015 – Proposed 79 FR 42504 Snake River Fall-Run ESU 10/2016 – Proposed 81 FR 74770 Snake River Spring/Summer-Run ESU 08/2011 76 FR 52317 Upper Willamette River Spring-run ESU	NLAA/NLAA – All ESUs
Chum Salmon (*Oncorhynchus keta*) - Columbia River ESU - Hood Canal Summer Run ESU	T – 70 FR 37160 T – 70 FR 37160	70 FR 52630	06/2013 78 FR 41911 05/2007 72 FR 29121	NLAA/NLAA – All ESUs
Coho Salmon (*Oncorhynchus kisutch*) - Lower Columbia River ESU - Oregon Coast ESU - Southern Oregon Northern California Coast ESU - Central California Coast ESU	T – 70 FR 37160 T – 73 FR 7816 T – 70 FR 37160 T – 70 FR 37160	81 FR 9252 73 FR 7816 64 FR 24049 64 FR 24049	06/2013 78 FR 41911 12/2016 81 FR 90780 2014 79 FR 58750 09/2012 77 FR 54565	NLAA/NLAA – All ESUs

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Sockeye Salmon (*Oncorhynchus nerka*) - Ozette Lake ESU - Snake River ESU	T – 70 FR 37160 E – 70 FR 37160	70 FR 52630 58 FR 68543	05/2009 06/2015	NLAA/NLAA – All ESUs
Argentine Angel Shark (*Squatina argentina*)	E – 81 FR 21722	-- --	-- --	NLAA/NLAA
Common Angel Shark (*Squatina squatina*)	E – 81 FR 50394	-- --	-- --	NLAA/NLAA
Sawback Angel Shark (*Squatina aculeata*)	E – 81 FR 50394	-- --	-- --	NLAA/NLAA
Smoothback Angel Shark (*Squatina oculata*)	E – 81 FR 50394	-- --	-- --	NLAA/NLAA
Spiny Angel Shark (*Squatina guggenheim*)	E – 81 FR 21722	-- --	-- --	NLAA/NLAA
Oceanic Whitetip Shark (*Carcharhinus longimanus*)	PT – 81 FR 96304	-- --	-- --	NLAA/NLAA
Scalloped Hammerhead Shark (*Sphyrna lewini*) - Eastern Atlantic DPS - Eastern Pacific DPS - Central and Southwest Atlantic DPS - Indo-West Pacific DPS	E – 79 FR 38213 E – 79 FR 38213 T – 79 FR 38213 T – 79 FR 38213	-- --	-- --	NLAA/NLAA – All DPSs
Narrownose Smoothhound Shark (*Mustelus schmitti*)	T – 81 FR 21722	-- --	-- --	NLAA/NLAA
Striped Smoothhound Shark (*Mustelus fasciatus*)	E – 81 FR 21722	-- --	-- --	NLAA/NLAA
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) - Gulf of Maine DPS - New York Bight DPS - Chesapeake Bay DPS - Carolina DPS - South Atlantic DPS	T – 77 FR 5880 E – 77 FR 5880 E – 77 FR 5880 E – 77 FR 5914 E – 77 FR 5914	81 FR 35701 – Proposed Gulf of Maine, New York Bight, and Chesapeake Bay DPSs 81 FR 36077 – Proposed Carolina and South Atlantic DPSs 81 FR 41926 – Corrected Proposed Carolina and South Atlantic DPSs	-- --	NLAA/NLAA
Chinese Sturgeon (*Acipenser sinensis*)	E – 79 FR 31222	-- --	-- --	NLAA/NLAA
Green Sturgeon (*Acipenser medirostris*) – Southern DPS	T – 71 FR 17757	74 FR 52300	-- --	NLAA/NLAA

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)	T – 56 FR 49653	68 FR 13370	09/1995	NLAA/NLAA
Sakhalin Sturgeon (*Acipenser mikadoi*)	E – 79 FR 31222	-- --	-- --	NLAA/NLAA
Steelhead Trout (*Oncorhynchus mykiss*)				NLAA/NLAA – All DPSs
- Lower Columbia River DPS	T – 71 FR 834	70 FR 52630	06/2013 78 FR 41911 Lower Columbia River DPS	
- Upper Columbia River DPS	T – 71 FR 834	70 FR 52630	08/2007 72 FR 57303 Upper Columbia River DPS	
- Middle Columbia River DPS	T – 71 FR 834	70 FR 52630	11/2009 74 FR 50165 Middle Columbia River DPS	
- Puget Sound DPS	T – 72 FR 26722	81 FR 9252	-- -- -- -- Puget Sound DPS	
- Upper Willamette River DPS	T – 71 FR 834	70 FR 52630	08/2011 76 FR 52317 Upper Willamette River DPS	
- Northern California DPS	T – 71 FR 834	70 FR 52488	10/2016 81 FR 7066 Northern California DPS	
- Central California Coast DPS	T – 71 FR 834	70 FR 52488	10/2016 81 FR 7066 Central California DPS	
- Snake River Basin DPS	T – 71 FR 834	70 FR 52630	10/2016 – Proposed 81 FR 74770 Snake River Basin DPS	
- California Central Valley DPS	T – 71 FR 834	70 FR 52488	07/2014 79 FR 42504 California Central Valley DPS	
- South-Central California Coast DPS	T – 71 FR 834	70 FR 52488	12/2013 78 FR 77430 South-Central California DPS	
- Southern California DPS	T – 71 FR 834	70 FR 52488	01/2012 77 FR1669 Southern California DPS	
Totoaba (*Totoaba macdonaldi*)	E – 44 FR 29480	-- --	-- --	NLAA/NLAA

E=Endangered
T=Threatened
PE=Proposed Endangered
PT=Proposed Threatened
DPS=Distinct Population Segment
ESU=Evolutionary Significant Unit
NE=No Effect
NLAA=Not Likely to Adversely Affect
LAA=Likely to Adversely Affect

4.1 Endangered Species Act-Listed and Proposed Cetaceans

Two species of cetacean, Maui’s dolphins and Indo-Pacific (Taiwanese) humpback dolphins, occur within close proximity to the action area and thus may be affected by the proposed action. However, due to the coastal habitat use of these species, their expected hearing ranges, and Navy’s proposed stand-off distance from shore, exposure to sound generated by Navy’s operation of SURTASS LFA sonar above ambient sound levels is expected to be extremely unlikely, as further detailed below.

Maui’s dolphins are a small sub-species of Hector’s dolphins that reside only off the coast of the North Island of New Zealand. They are currently proposed for listing under the ESA as endangered due to their small population size, which is likely a result of interactions with recreational and commercial fisheries (Manning and Grantz. 2016). Maui’s dolphins are an extremely coastal species, with animals being seen no further than seven nautical miles offshore (Fresne 2010; Manning and Grantz. 2016). While we are aware of no information on the hearing range of Maui’s dolphins specifically, based on the vocalizations of Maui’s dolphins and the closely related South Island Hector’s dolphin, we expect that they hear best between frequencies of 112 and 130 kHz. However, we recognized they may be sensitive to frequencies outside of this range, specifically within the range that other dolphin species are known to hear, between 150 Hz and 160 kHz (NOAA 2016a).

Indo-Pacific (Taiwanese) humpback dolphins are a medium sized delphinid species that occurs only off the west coast of Taiwan. They are currently proposed as endangered under the ESA due to their small population size, which is likely the result of pollution, habitat loss, underwater noise, and interactions with fisheries (Dungan et al. 2011). Like Maui’s dolphins, Indo-Pacific (Taiwanese) humpback dolphins have an extremely coastal range, only occurring out to 5.6 km (3 nmi) from shore (Dares et al. 2017; Dares et al. 2014). We are aware of no information on Indo-Pacific (Taiwanese) humpback dolphin hearing and vocalizations specifically, but information on other Indo-Pacific humpback dolphins is applicable. Like most odontocetes, Indo-Pacific (Taiwanese) humpback dolphins produce a variety of clicks and whistles. Whistles range in frequency from 520 Hz to 33 kHz, while echolocation clicks occur at higher frequencies of 43.5 to 142.1 kHz (Li et al. 2013; Wang et al. 2013; Wang et al. 2014). Based on these data, Indo-Pacific (Taiwanese) humpback dolphins are expected to have a maximum hearing range between frequencies of approximately 500 Hz to 145 kHz (Li et al. 2013; Li et al. 2012; Wang et al. 2014).

The Navy’s SURTASS LFA sonar operations would occur no closer than 22 km (12 nmi) to shore with the proposed stand-off distance. At this stand-off distance, no interaction with Navy vessels would occur, leaving only sound from Navy SURTASS LFA sonar as the only possible stressor that would impact Maui’s and Indo-Pacific (Taiwanese) humpback dolphins. However, within shore of this standoff distance, the Navy would ensure sound levels would not exceed 180 dB re: 1 µPa (rms) sound pressure level. Given the narrow coastal ranges of Maui’s (13 km [7 nmi] from shore) and Indo-Pacific (Taiwanese) humpback (5.6 km [3 nmi] from shore) dolphins, and Navy's proposed stand-off distance, it is extremely unlikely that any Maui's or Indo-Pacific (Taiwanese) humpback dolphins would be exposed sound from SURTASS LFA sonar that would be above ambient sound levels. Exposure above ambient would only occur if a Maui's or Indo-Pacific (Taiwanese) humpback dolphins were to travel far offshore, outside of their typical range, at the same time and location where the Navy was operating SURTASS LFA sonar right at the 22 km (12 nmi) stand-off distance. Even if this were to occur, both Maui's and Indo-Pacific (Taiwanese) humpback dolphins are expected to hear best in the mid-frequency range (NOAA 2016a). While the 100 and 500 Hz frequencies that would be used for SURTASS LFA may be audible to Maui's and Indo-Pacific (Taiwanese) humpback dolphins if these species were exposed to very high source levels, they are not in the species best hearing range and are unlikely to be audible at the distances at which animals would actually be exposed. Based on these factors, we find it highly unlikely that Maui's and Indo-Pacific (Taiwanese) humpback dolphins will be exposed to sound from SURTASS LFA sonar above that of natural ambient noise levels, and as such we find these effects to be discountable. We conclude that the Navy's SURTASS LFA sonar operations in the action area for the period of August 2017 through August 2022, and ongoing for the reasonably foreseeable future is not likely to adversely affect Maui's and Indo-Pacific (Taiwanese) humpback dolphins. As a result, Maui's and Indo-Pacific (Taiwanese) humpback dolphins will not be considered further in this opinion.

4.2 Endangered Species Act-Listed and Proposed Elasmobranchs

ESA-listed (or proposed for ESA-listing) elasmobranchs (blackchin guitarfish, Brazilian guitarfish, common guitarfish, giant manta ray, Argentine angel shark, common angel shark, sawback angel shark, smoothback angel shark, spiny angel shark, oceanic whitetip shark, narrownose smoothhound shark, striped smoothhound shark, and scalloped hammerhead shark DPSs) may occur in the action area. Populations for some species and DPSs (e.g., scalloped hammerhead sharks) are generally delineated by ocean basins based on discrete differences in genetic structure and limited transoceanic migrations of the species. Unless otherwise noted, the information presented below was obtained from status review report and other listing documents (Table 46).

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 elasmobranchs fishes suggest detection of sounds from 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 Jr. 2001). However, unlike most teleost fish, elasmobranchs do not have swimbladders, and thus are unable to detect sound pressure (Casper et al. 2012). Given their assumed hearing range, elasmobranchs are anticipated to be able to detect SURTASS LFA sonar if exposed. However, the duration and intensity of low-frequency acoustic stressors and the implementation of mitigation measures (described in section 0) will likely minimize the effect this stressor has on elasmobranchs.

Furthermore, although some elasmobranchs have been known to respond to anthropogenic noise, in general elasmobranchs are not particularly sensitive to noise (Casper et al. 2012).

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 at an onset rate of 96 dB per second to a peak amplitude of 123 dB received level from a continuous level, just masking broadband ambient noise (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, some elasmobranchs 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 substantially different from the SURTASS LFA sonar signals. Myrberg et al. (1978) reported that silky shark withdrew 10 m (33 ft) from a speaker broadcasting a 150 to 600 Hz sound with a sudden onset and peak source level of 154 dB. These sharks avoided a pulsed low frequency attractive sound when its sound level was abruptly increased by more than 20 dB. Other factors enhancing withdrawal were sudden changes in the spectral or temporal qualities of the transmitted sound. The pelagic oceanic whitetip (*Carcharhinus longimanus*) 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 a fishes with no swimbladders exhibiting a behavioral response to LFA sonar was low, regardless of the distance from the sound source. The authors did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking would 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 LFA sonar was low, regardless of the distance from the sound source.

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 and DPSs. However, given the signal type and level of exposure to the low frequency signals used in SURTASS LFA sonar operations, we do not expect significant responses (including significant behavioral adjustments, TTS, PTS, injury, or mortality). We do not expect injury or mortality to result from any exposures. Additionally, as stated previously, Popper et al. (2014b) concluded that behavioral reactions of fish in response to exposure to LFA sonar were unlikely, regardless of the distance from the sound source. The most likely response of ESA-listed elasmobranchs exposed to LFA sonar, if any, would 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, they would not have fitness impacts for the individual, the populations, or the DPS.

Therefore, the potential effect of SURTASS LFA sonar operations on ESA-listed elasmobranch species (blackchin guitarfish, Brazilian guitarfish, common guitarfish, giant manta ray, Argentine angel shark, common angel shark, sawback angel shark, smoothback angel shark, spiny angel shark, oceanic whitetip shark, narrownose smoothhound shark, striped smoothhound shark, and scalloped hammerhead shark DPSs) is insignificant. We conclude that the Navy's operation of SURTASS LFA sonar in the action area for the period of August 2017 through August 2022, and ongoing for the reasonably foreseeable future is not likely to adversely affect ESA-listed elasmobranch species and DPSs. As a result, ESA-listed elasmobranchs (blackchin guitarfish, Brazilian guitarfish, common guitarfish, giant manta ray, Argentine angel shark, common angel shark, sawback angel shark, smoothback angel shark, spiny angel shark, oceanic whitetip shark, narrownose smoothhound shark, striped smoothhound shark, and scalloped hammerhead shark DPSs) will not be considered further in this opinion.

4.3 Endangered Species Act-Listed Salmonids

ESA-listed salmonids (Atlantic [Gulf of Maine DPS], all Chinook, chum, coho, and sockeye ESUs, and steelhead DPSs) may occur in the action area during their ocean migrations. Data indicates that Chinook, coho, sockeye, and chum salmon, and steelhead may be found in SURTASS LFA sonar current mission areas in the North Pacific Ocean (mission areas 1, 12, 22, 22, and 26, (Masuda et al. 2015; Myers et al. 2006; Myers et al. 1996) (Fisher and Pearcy 1995; Pearcy and Fisher 1990; PFMC 2014) Bi et al. (2011) (Daly et al. 2014; Light et al. 1989; NMFS 2015b)). In addition, these species overlap with the larger action area. Atlantic salmon may overlap with current mission areas 24 and 25, and also overlap with the larger action area. Given that these species ranges overlap SURTASS LFA current mission areas and the larger action area, they may be exposed to sound from SURTASS LFA sonar. In addition, salmonids hearing range (100 to 300 Hz) overlaps with SURTASS LFA sonar frequencies, indicating that they may be able to detect SURTASS LFA sonar if close enough to the source (Hawkins and Popper 2016; Ladich and Fay 2013).

Hastings et al. (1996) studied the effects of low frequency underwater sound on fish hearing. The authors exposed the teleost fish *Astronotus ocellatus* to sound of varying frequencies (60 or 300 Hz), duty cycles (20 percent or continuous), and intensity (100, 400, or 180 dB re: 1 µPa). The only treatment where the authors observed some limited damage to sensory hair cells was with one hour of continuous exposure at 300 Hz and 180 dB, but this result was inconsistent. The authors recommended caution if attempting to extrapolate this result to other species or other sound sources, and also suggested that damage would be even more limited with shorter term stimulation or if fish were free to leave the site of simulation. For the 2015 consultation on the

Navy's Northwest Training and Testing activities (NMFS 2015a), NMFS and the Navy developed sound exposure criteria for low frequency sonar for fish. Though SURTASS LFA sonar operations was not evaluated, for other low frequency sonar sources (i.e., low-frequency sources equal to 180 dB and up to 200 dB) it was determined that fish would need to be within one m (3.3 ft) of the sonar source in order to experience TTS.

Popper et al. (2008; 2007; Popper and Hastings 2009b) investigated the effects of exposing several fish species, including a salmonid, to LFA sonar, focusing on the hearing and on non-auditory tissues. Their 2007 study exposed fishes to LFA sonar pulses for time intervals that would be substantially longer than what would occur in nature, but fishes did not experience mortalities or damage to body tissues at the gross or histological level. Some fish experienced temporary losses in hearing sensitivity, but they recovered within several days of exposure. Popper et al. (2014b) did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking would result in a narrow range of frequencies being masked (Popper et al. 2014b). Popper et al. (2014b) also concluded that the risk of immediate mortality, mortal injury, or recoverable injury for fishes with swimbladders not involved in hearing exposed to low frequency sonar was low, regardless of the distance from the sound source. Low frequency sonar lacks the fast rise times, high peak pressures, and high acoustic impulse that could lead to mortality or injury in fishes.

ESA-listed salmonids in relatively close proximity to the LFA sonar source (e.g., within 1 m [3.3 ft] where TTS could occur) would likely move to actively avoid being within one meter of the source because they would likely perceive the sonar source as a potential predator. Additionally, any hearing loss would be temporary, and individuals would be expected to fully recover shortly after exposure (Lombarte et al. 1993; Smith et al. 2006). Also, the ESA-listed salmonid species considered in this opinion lack notable hearing specialization, which minimizes the likelihood of any instance of TTS affecting an individual's fitness. To our knowledge, no studies have examined the fitness implications of a fish, without noticeable hearing specialization, experiencing TTS. Popper et al. (2014b) suggested that fishes experiencing TTS may have a decreased ability to communicate, detect predators or prey, or assess their environment. However, the salmonid species considered in this opinion are able to rely on alternative mechanisms (e.g., sight, lateral line system) to detect prey, avoid predators, spawn, and to orient in the water column (Popper et al. 2014b). Additionally, hearing is not thought to play a role in salmon migration (e.g., Putnam et al. 2013). Because these species are able to rely on alternative mechanisms for these essential life functions, instances of TTS would not likely disturb a fish to such an extent as to significantly disrupt normal behavioral patterns, including breeding, feeding, or sheltering and would not rise to the level of take. Therefore, the effect of exposure to LFA sonar that may result in TTS is insignificant and is not likely to adversely affect the ESA-listed salmonid species considered in this opinion.

We also assessed the potential for exposure to SURTASS LFA sonar to result in behavioral responses in ESA-listed salmonids. There is a lack of studies that have investigated the behavioral reactions of unrestrained fishes to anthropogenic sound, especially in the natural environment. Studies of caged fishes have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (McCauley et al. 2000; Pearson et al. 1992). However, Popper et al. (2014b) concluded that the relative risk of a fish exhibiting a behavioral response to low-frequency sonar was low, regardless of the distance from the sound source. Should an ESA-listed salmonid exhibit a behavioral response from exposure to low-frequency sonar, we do not expect these reactions to have any measurable effects of any individual's fitness. We expect individuals that exhibit a temporary behavioral response would return to pre-exposure behavior immediately following each exposure. Exposure time is expected to be brief because both the vessel and the individual fish are moving while in the ocean environment. Similar to instances of TTS, these short-term behavioral reactions would not likely disturb a salmonid to such an extent as to significantly disrupt normal behavioral patterns, and such reactions would rise to the level of take.

Therefore, the potential effects of SURTASS LFA sonar operations on ESA-listed salmonid species (Atlantic [Gulf of Maine DPS], all Chinook, chum, coho, and sockeye ESUs, and steelhead DPSs) are insignificant. We conclude that the Navy's SURTASS LFA sonar operations in the action area for the period of August 2017 through August 2022, and ongoing for the reasonably foreseeable future is not likely to adversely affect ESA-listed salmonid species. As a result, ESA-listed salmonids will not be considered further in this opinion.

4.4 Endangered Species Act-Listed Sturgeon

ESA-listed sturgeon (i.e., all Atlantic DPSs, Chinese, Green Southern DPS, Gulf, and Sakhalin) may occur in the action area during their ocean migrations.

While sturgeon have swimbladders, they are not known to be used hearing, and thus sturgeon appear to only rely directly on their ears for hearing. Popper (2005) reported that studies measuring responses of the ear of European sturgeon (*Acipenser sturio*) using physiological methods suggest sturgeon are likely capable of detecting sounds from below 100 Hz to about 1 kHz, indicating that sturgeon should be able to localize or determine the direction of origin of sound. Meyer and Popper (2002) recorded auditory evoked potentials of varying frequencies and intensities for lake sturgeon (*Acipenser fulvescens*) and found that lake sturgeon can detect pure tones from 100 Hz to 2 kHz, with best hearing sensitivity from 100 to 400 Hz. They also compared these sturgeon data with comparable data for Oscar (*Astronotus ocellatus*) and goldfish (*Carassius auratus*) and reported that the auditory brainstem responses for the lake sturgeon were more similar to goldfish (which is considered a hearing specialist that can hear up to five kHz) than to the oscar (which is a non-specialist that can only detect sound up to 400 Hz); these authors, however, felt additional data were necessary before lake sturgeon could be considered specialized for hearing (Meyer and Popper 2002).

Lovell et al. (2005) also studied sound reception and the hearing abilities of paddlefish (*Polyodon spathula*) and lake sturgeon. Using a combination of morphological and physiological techniques, they determined that paddlefish and lake sturgeon were responsive to sounds ranging in frequency from 100 to 500 Hz, with the lowest hearing thresholds from frequencies in a bandwidth of between 200 and 300 Hz and higher thresholds at 100 and 500 Hz; lake sturgeon were not sensitive to sound pressure. We assume that the hearing sensitivities reported for these other species of sturgeon are representative of the hearing sensitivities of all Atlantic DPSs, Chinese, Green Southern DPS, Gulf, and Sakhalin sturgeon.

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

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

The precise expected response of ESA-listed sturgeon to low-frequency acoustic energy is not completely understood due to a lack of sufficient experimental and observational data for this taxon. However, given the signal type and level of exposure to the low frequency signals used in SURTASS LFA sonar operations, and the fact that most sturgeon are found in a nearshore coastal or freshwater areas, we do not expect frequent exposure or significant responses from any exposures (including significant behavioral adjustments, TTS, PTS, injury, or mortality). We do not expect injury or mortality to result from any exposures. Additionally, as stated previously, Popper et al. (2014b) concluded that behavioral reactions of fish in response to exposure to LFA sonar was unlikely, regardless of the distance from the sound source. The most likely response of ESA-listed sturgeon exposed to LFA sonar, if any, would be minor temporary changes in behavior including increased swimming rate, avoidance of the sound source, or changes in orientation to the sound source, none of which rise to the level of take. If these behavioral reactions were to occur, they will not have fitness impacts for the individual, the population, or the DPS.

Therefore, the potential effect of SURTASS LFA sonar on ESA-listed sturgeon is insignificant. We conclude that the Navy’s SURTASS LFA sonar operations in the action area for the period of August 2017 through August 2022, and ongoing for the reasonably foreseeable future is not likely to adversely affect ESA-listed sturgeon. As a result, ESA-listed sturgeon are not considered further in this opinion.

4.5 Other Endangered Species Act-Listed Fishes

Several other ESA-listed fishes may be found within the action area, and thus be exposed to SURTASS LFA sonar including Southern DPS of Pacific eulachon, Tanzania DPS of African Coelacanth, Totoaba, and Gulf, Island, and Nassau grouper. Below we summarize information on the hearing range and vocalizations of these species when available, and evaluate the effects of exposure to SURTASS LFA sonar to these other ESA-listed fishes.

The Southern DPS of Pacific Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish that can be found in the eastern Pacific Ocean. They may be found both within specific mission areas, as well as the larger action area. We do not have specific information on hearing in Southern DPS of Pacific eulachon, but we assume that they are hearing generalists whose hearing sensitivities would be similar to salmon. Species in the family Salmonidae have similar auditory systems and hearing sensitivities (Popper 1977; Popper et al. 2007; Wysocki et al. 2007). Most of the data available on this group resulted from studies of the hearing capability of Atlantic salmon (*Salmo salar*), which is a “hearing generalist” with a relatively poor sensitivity to sound (Hawkins and Johnstone 1978). Based on the information available, we assume that the eulachon considered in this consultation have hearing sensitivities ranging from less than 100 to about 580 Hz (Hawkins and Johnstone 1978; Knudsen et al. 1992; Knudsen et al. 1994; Popper 2008). As such, they would likely be able to detect SURTASS LFA sonar depending on the distance of exposure.

Coelacanth belong to an ancient lineage of fishes, the class Sarcopterygii or lobe-finned fishes, and were once thought to be extinct until the discovery of a living African coelacanth off the coast of South Africa in 1938. The Tanzania DPS of African coelacanth inhabit deep waters off the coast of Tanzania. It does not occur within any current mission areas, but is present in the larger action area of the proposed action. Coelacanth are unique among fishes in that they are thought to be the only known species to have rudimentary basila papilla, an auditory sensory organ found in lizards, amphibians, and birds (Fritzsch 1987). While there are several studies that examine the morphology of coelacanth ears (Fritzsch 1987; Platt 1994), we are aware of no studies on the hearing abilities or vocalizations of coelacanth. However, several studies exist on the hearing of lungfishes, the only other extant Sarcopterygii. These data indicate that African lungfish (*Protopterus annectens*) are not particularly sensitive to sound, but hear low frequencies, with the best sensitivity between 50 and 80 Hz (Christensen-Dalsgaard et al. 2011; Christensen et al. 2015; Ladich and Fay 2013). Given the major differences between coelacanth and lungfishes, who live in shallow, freshwater water and can breathe air, it is not clear how well the hearing range of lungfish applies to coelacanth. Nonetheless, these data represent our best understanding of coelacanth hearing at this time and likely for the foreseeable future given the rarity of African coelacanth. As such, coelacanth are expected to hear best below those frequencies (100 to 500 Hz) that would be used during SURTASS LFA sonar. Nonetheless, given that lungfish appear to still be able to hear beyond 80 Hz to some degree, and the uncertainty in applying lungfish hearing abilities to coelacanth, we assume Tanzania DPS of

African coelacanth would be able to hear SURTASS LFA sonar depending on the distance of exposure.

Totoaba are the largest member of the Sciaenidae family and are only found in the Gulf of California (Valenzuela-Quiñonez et al. 2015). While their range does not overlap with any current mission areas, it does overlap with the larger action area for the proposed action. Fish in the family Sciaenidae are also known as drums and croakers because of their tendency to produce a variety of sounds (Ramcharitar et al. 2006). While we are aware of no studies on the hearing range of totoaba specifically, several studies on other hearing ranges of Sciaenidae species exist. A recent review covering auditory evoked potential audiometry of a variety of fishes indicate that Sciaenidae consistently exhibit the best hearing sensitivity between 100 and 400 Hz (Ladich and Fay 2013). As such, we expect that totoaba are likely be able to detect SURTASS LFA sonar depending on the distance of exposure.

Gulf, Island, and Nassau grouper are all members of the subfamily Epinephelinae. Gulf grouper are found only within the Gulf of California. Island grouper are found exclusively in waters around Macronesia. Nassau grouper are found in the Gulf of Mexico and the Caribbean Sea. As such, while these species may not overlap with current mission areas, they do occur within the larger action area for the proposed action. Groupers are known to produce a variety of sounds associated with reproductive behavior and alarm calls, with several species having been studied in detail. Like other groupers, Nassau groupers produce sounds ranging from approximately 10 to 2000 Hz, with most sounds being low frequency, below 600 Hz (Hazlett and Winn 1962; Schärer et al. 2012b). We are aware of no data specifically on sounds produced by Island and Gulf grouper, but assume they are similar to that produced by Nassau groupers described above and other related species (Mann et al. 2009; Nelson et al. 2011; Rowell et al. 2012; Schärer et al. 2012a), and so are likely low in frequency. We could only find hearing data on one species of grouper, the Leopard coral grouper (*Plectropomus leopardus*), but these data are consistent with groupers having the best hearing sensitivity at low frequencies, between 100 and 300 Hz (Ladich and Fay 2013; Wright et al. 2009). As such, Gulf, Island, and Nassau grouper are likely be able to detect SURTASS LFA sonar depending on the distance of exposure.

Based on the above review, Pacific eulachon (Southern DPS), African Coelacanth (Tanzania DPS), Totoaba, and Gulf, Island, and Nassau grouper are likely to be able to detect sounds produced by SURTASS LFA sonar. As such, we evaluate the potential for this exposure to cause significant behavioral adjustments, TTS, PTS, injury, and mortality. While we are aware of no studies specifically looking at responses of Pacific eulachon (Southern DPS), African Coelacanth (Tanzania DPS), Totoaba, and Gulf, Island, and Nassau grouper to low frequencies sounds like those that would be produced by SURTASS LFA, data on other fishes, including those previously described for elasmobranchs, salmonids, and sturgeon are informative.

Hastings et al. (1996) studied the effects of low frequency underwater sound on fish hearing. The authors exposed the teleost fish *Astronotus ocellatus* to sound of varying frequencies (60 or 300 Hz), duty cycles (20 percent or continuous), and intensity (100, 400, or 180 dB re: 1 μPa). The only treatment where the authors observed some limited damage to sensory hair cells was with one hour of continuous exposure at 300 Hz and 180 dB, but this result was inconsistent. The authors recommended caution if attempting to extrapolate this result to other species or other sound sources, and also suggested that damage would be even more limited with shorter term stimulation or if fish were free to leave the site of simulation. For the 2015 consultation on the Navy's Northwest Training and Testing activities (NMFS 2015a), NMFS and the Navy developed sound exposure criteria for low frequency sonar for fish. Though SURTASS LFA sonar operations was not evaluated, for other low frequency sonar sources (i.e., low-frequency sources equal to 180 dB and up to 200 dB) it was determined that fish would need to be within one m (3.3 ft) of the sonar source in order to experience TTS.

Popper et al. (2008; 2007; Popper and Hastings 2009b) investigated the effects of exposing several fish species to LFA sonar, focusing on the hearing and on non-auditory tissues. Their 2007 study exposed fishes to LFA sonar pulses for time intervals that would be substantially longer than what would occur in nature, but fishes did not experience mortalities or damage to body tissues at the gross or histological level. Some fishes experienced temporary losses in hearing sensitivity, but they recovered within several days of exposure. Popper et al. (2014b) did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking would result in a narrow range of frequencies being masked (Popper et al. 2014b). Popper et al. (2014b) also concluded that the risk of immediate mortality, mortal injury, or recoverable injury for fishes with swimbladders not involved in hearing exposed to low frequency sonar was low, regardless of the distance from the sound source. Low frequency sonar lacks the fast rise times, high peak pressures, and high acoustic impulse that could lead to mortality or injury in fishes.

ESA-listed fishes in relatively close proximity to the LFA sonar source (e.g., within 1 m [3.3 ft] where TTS could occur) would likely move to actively avoid being within one meter of the source because they would likely perceive the sonar source as a potential predator. Additionally, any hearing loss would be temporary, and individuals would be expected to fully recover shortly after exposure (Lombarte et al. 1993; Smith et al. 2006). Also, all the ESA-listed fishes considered in this opinion lack notable hearing specialization, which minimizes the likelihood of any instance of TTS affecting an individual's fitness. To our knowledge, no studies have examined the fitness implications of a fish without noticeable hearing specialization experiencing TTS. Popper et al. (2014b) suggested that fishes experiencing TTS (may have a decreased ability to communicate, detect predators or prey, or assess their environment. However, the species considered in this opinion are able to rely on alternative mechanisms (e.g., sight, lateral line system) to detect prey, avoid predators, spawn, and to orient in the water column (Popper et al. 2014b). Because these species are able to rely on alternative mechanisms for these essential life functions, instances of TTS would not likely disturb a fish to such an extent as to significantly disrupt normal behavioral patterns, including breeding, feeding, or sheltering and would not rise to the level of take. Therefore, the effect of exposure to LFA sonar that may result in TTS is insignificant and is not likely to adversely affect the ESA-listed fish species considered in this opinion.

We also assessed the potential for exposure to SURTASS LFA sonar to result in behavioral responses. There is a lack of studies that have investigated the behavioral reactions of unrestrained fishes to anthropogenic sound, especially in the natural environment. Studies of caged fishes have identified three basic behavioral reactions to sound: startle, alarm, and avoidance (McCauley et al. 2000; Pearson et al. 1992). However, Popper et al. (2014b) concluded that the relative risk of a fish exhibiting a behavioral response to low-frequency sonar was low, regardless of the distance from the sound source. Should an ESA-listed fish exhibit a behavioral response from exposure to low-frequency sonar, we do not expect these reactions to have any measurable effects of any individual's fitness. We expect individuals that exhibit a temporary behavioral response would return to pre-exposure behavior immediately following each exposure. Exposure time is expected to be brief because both the vessel and the individual fish are moving while in the ocean environment. Similar to instances of TTS, these short term behavioral reactions would not likely disturb a fish to such an extent as to significantly disrupt normal behavioral patterns, and such reactions would rise to the level of take.

Therefore, the potential effects of SURTASS LFA sonar operations on Southern DPS of Pacific eulachon, Tanzania DPS African Coelacanth, Totoaba, and Gulf, Island, and Nassau grouper are insignificant. We conclude that the Navy's SURTASS LFA sonar operations in the action area for the period of August 2017 through August 2022, and ongoing for the reasonably foreseeable future is not likely to adversely affect Southern DPS of Pacific eulachon, Tanzania DPS of African Coelacanth, Totoaba, and Gulf, Island, and Nassau grouper. As a result, these ESA-listed fishes are not considered further in this opinion.

4.6 Critical Habitat

Designated critical habitat for several ESA-listed species occurs within the action area and may be affected by the proposed action. This includes designated critical habitat for Southern DPS of green sturgeon, Hawaiian monk seals, leatherback turtles, Northwest Atlantic DPS of loggerhead turtles, North Atlantic right whales, North Pacific right whales, and Western DPS of Steller sea lions. Each critical habitat is characterized by physical and biological features (previously referred to by NMFS as primary constituent elements) that are essential to the conservation of the ESA-listed species for which the habitat was designated. Below we describe each critical habitat along with its physical and biological features, and then evaluate the effects that the proposed action may have on these physical and biological features. While some critical habitat designations include nearshore, coastal, riverine, estuarine, and/or terrestrial habitat, given the proposed standoff distance, we focus our effects analysis on designated marine areas. In determining if designated critical habitat is likely to be adversely modified or destroyed, we assess whether the proposed action would appreciably diminish 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 CFR §402.02). If the proposed action would not appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species, we conclude that the proposed action is not likely to adversely modify or destroy the designated critical habitat and do not consider that critical habitat further[2].

4.6.1 Green Sturgeon – Southern Distinct Population Segment Critical Habitat

Critical habitat was designated for Southern DPS of green sturgeon on October 9, 2009, and includes marine, coastal bay, estuarine, and freshwater areas (74 FR 52300) . Only the marine portion of designated Southern DPS of green sturgeon critical habitat occurs with the action area and thus may be affected by the proposed action. Critical habitat within marine waters includes areas within the 60-fathom (110 m [361ft]) isobath from Monterey Bay to the U.S.-Canada border. Many coastal bays and estuaries are designated as critical habitat, including: San Francisco Estuary and Humboldt Bay in California; Coos, Winchester, Yaquina, and Nehalem bays in Oregon; Willapa Bay and Grays Harbor in Washington; and the lower Columbia River estuary from the mouth to river km 74 to the Bonneville Dam. Physical and biological features considered in the designation of the marine areas of Southern DPS of green sturgeon critical habitat include (1) a migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats, (2) nearshore marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal behavior, growth, and viability of sub-adult and adult green sturgeon, and (3) abundant prey items for sub-adults and adults, which may include benthic invertebrates and fishes (74 FR 52300).

4.6.2 Hawaiian Monk Seal Critical Habitat

Hawaiian monk seal critical habitat was originally designated on April 30, 1986 (51 FR 16047) and was extended on May 26, 1988 (53 FR 18988) (Figure 27). It includes all beach areas, sand spits, and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of 37 m (121.4 ft) around the northwestern Hawaiian Islands breeding atolls and islands. On September 21, 2015, NMFS published a final rule to revise designated critical habitat for Hawaiian monk seals (80 FR 50925), extending the current designation in the northwestern Hawaiian Islands out to the 200 m (656.2 ft) depth contour (including Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island). It also designated six new areas in the main Hawaiian Islands (i.e., terrestrial and marine habitat from 5 m [16.4 ft] inland from the shoreline extending seaward to the 200 m (656.2 ft) depth contour around Kaula, Niihau, Kauai, Oahu, Maui, Nui, and Hawaii). Only the marine portion of designated Hawaiian monk seal critical habitat, which includes the seafloor plus waters 10 m (33 ft) above seafloor off the Main and Northwest Hawaiian Islands from depths of 80 to 200 m

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[2] Note that the *Federal Register* notices for some designated critical habitat discussed in this section are listed in Table 46.

(262.5 to 656.2 ft), occurs with the action area and thus may be affected by the proposed action. The physical and biological features identified for this area include, adequate prey quality and quantity for juvenile and adult monk seal foraging (80 FR 50925).

4.6.3 Leatherback Sea Turtle Critical Habitat

While two areas of leatherback turtle critical habitat have been designated, one in the U.S. Virginia Islands and the other off the west coast of the U.S., only the U.S. west coast designated critical habitat occurs within the action area and thus, may be affected by the proposed action. On January 20, 2012, NMFS issued a final rule to designate critical habitat for the leatherback turtle along the west coast of the U.S. (50 CFR §226) (Figure 52). This designation includes approximately 43,798 km^2 (12,769 nmi^2) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 m (9,842.5 ft) depth contour; and 64,760 km^2 (18,881 nmi^2) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m (6,561.7 ft) depth contour. The designated areas comprise approximately 108,558 km^2 (31,650 nmi^2) of marine habitat and include waters from the ocean surface down to a maximum depth of 80 m (262.5 ft). They were designated specifically because of the presence of one physical and biological features essential to the conservation of leatherback turtles: the occurrence of prey species, primarily *scyphomedusae* of the order *Semaeostomeae* (i.e., jellyfish), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks (50 CFR §226).

4.6.4 Loggerhead Sea Turtle – Northwest Atlantic Distinct Population Segment Critical Habitat

On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead turtles along the U.S. Atlantic and Gulf of Mexico coasts from North Carolina to Mississippi (79 FR 39856) (Figure 59). These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding and foraging areas, migratory corridors, and *Sargassum* habitat. The critical habitat is categorized into 38 occupied marine areas and 1,102.4 km (685 miles) of nesting beaches. Only the marine areas designated by NMFS are located within the action area, and thus considered further. The physical and biological features identified for this habitat include:

a. Nearshore reproductive habitat:
    (i) Nearshore waters directly off the highest density nesting beaches and their adjacent beaches, as identified in 50 CFR 17.95(c), to 1.6 km offshore;
    (ii) Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water; and
    (iii) Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents.

(2) Winter habitat:

  - (i) Water temperatures above 10° C from November through April;
  - (ii) Continental shelf waters in proximity to the western boundary of the Gulf Stream; and
  - (iii) Water depths between 20 and 100 m (66 to 328 ft).
- (3) Breeding habitat:
  - (i) High densities of reproductive male and female loggerheads;
  - (ii) Proximity to primary Florida migratory corridor; and
  - (iii) Proximity to Florida nesting grounds.
- (4) Constricted migratory habitat:
  - (i) Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and
  - (ii) Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas.
- (5) Sargassum habitat:
  - (i) Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the Sargassum community in water temperatures suitable for the optimal growth of *Sargassum* and inhabitance of loggerhead turtles;
  - (ii) *Sargassum* in concentrations that support adequate prey abundance and cover;
  - (iii) Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and
  - (iv) Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e., greater than 10 m (33 ft) depth.

4.6.5 North Atlantic Right Whale Critical Habitat

Critical habitat for North Atlantic right whales was designated in 1994 (59 FR 28805) and expanded in 2016 (81 FR 4937). It includes two major units: Unit 1 located in the Gulf of Maine and Georges Bank Region and Unit 2 located off the coast of North Carolina, South Carolina, Georgia, and Florida (Figure 17). Unit 1 consists of important foraging area and contains the following physical and biological features essential to the conservation of the species: the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the zooplankton species *Calanus finmarchicus* for North Atlantic right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes, low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and diapuasing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region. Unit 2 consists of an important calving area and contains the following physical and biological features essential to the conservation of the species: sea surface conditions associated with Force 4 or less on the Beaufort Scale, sea surface temperatures 7 to 17° C, and water depths of 6 to 28 m (19.7 to 91.9 ft), where these features simultaneously co-occur over contiguous areas of at least 792.3 km^2 (231 nmi^2) of ocean waters during the months of November through April.

4.6.6 North Pacific Right Whale Critical Habitat

In 2008, NMFS designated critical habitat for the North Pacific right whale, which includes an area in the Southeast Bering Sea and an area south of Kodiak Island in the Gulf of Alaska (Figure 19). Only the area south of Kodiak Island in the Gulf of Alaska is within the action area, as Navy's SURTASS LFA sonar routine training, testing, and military operations do not occur in northern Arctic waters. Designated North Pacific right whale critical habitat is influenced by large eddies, submarine canyons, or frontal zones which enhance nutrient exchange and act to concentrate prey. North Pacific right whale designated critical habitat is adjacent to major ocean currents and characterized by relatively low circulation and water movement. The designated critical habitat supports feeding by North Pacific right whales because they contain specific physical and biological features that include: nutrients, physical oceanographic processes, certain species of zooplankton, and a long photoperiod due to the high latitude (73 FR 19000).

4.6.7 Steller Sea Lion – Western Distinct Population Segment Critical Habitat

In 1997, NMFS designated critical habitat for the Steller sea lion (58 FR 45269), which remains in effect for the Western DPS despite the Eastern DPS being delisted in 2013 (78 FR 66139). The designated critical habitat includes specific rookeries, haul-outs, and associated areas, as well as three marine foraging areas that are considered to be essential for health, continued survival, and recovery of the species (Figure 33). In Alaska, areas include major Steller sea lion rookeries, haul-outs and associated terrestrial, air, and aquatic zones. Only the aquatic portions of designated critical habitat, south of the Aleutian Islands and the Alaskan peninsula, occur within the action area given Navy's proposed coastal standoff distance. These aquatic zones extend 0.9 km (0.5 nmi) seaward from the major rookeries and haul-outs east of 144° West. In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikof Strait (in the Gulf of Alaska), Bogoslof Island, and Seaguam Pass (the latter two are in the Aleutians). These sites are located near Steller sea lion abundance centers and include important foraging areas, large concentrations of prey, and host large commercial fisheries that often interact with the species. The physical and biological features identified for the aquatic areas of Steller sea lion designated critical habitat that occur within the action area are those that support foraging, such as adequate prey resources and available foraging habitat (58 FR 45269). While Steller sea lions do rest in aquatic habitat, there was insufficient information available at the time critical habitat was designated to include aquatic resting sights as part of the critical habitat designation (58 FR 45269).

4.6.8 Effects to Designated Critical Habitat

Marine areas of the above described designated critical habitats occur within the action area and as such, may be affected by Navy's SURTASS LFA sonar routine training, testing, and military operations. Below we first assess the probable exposure of these critical habitats to Navy's SURTASS LFA sonar routine training, testing, and military operations. We then evaluate the possible effects the proposed action may have on the physical and biological features of each critical habitat that would be exposed, in order to determine if the proposed action is likely to adversely modify or destroy the designated critical habitat.

The Navy proposes to restrict its SURTASS LFA sonar routine training, testing, and military operations such that the LFA sonar sound field would be below received levels of 180 dB re: 1 μPa (rms) at the outer (seaward) boundary of several designated marine mammal OBIAs during specified biologically important season or time period. The Navy also adds an extra buffer zone around the marine mammal OBIAs that ensures no animals are exposed to a sound pressure level greater than approximately 174 dB re: 1 μPa. Several of these OBIAs overlap partially, and in some cases completely, with designated critical habitat for ESA-listed species, and as such, minimize exposure of these critical habitats to Navy's SURTASS LFA sonar routine training, testing, and military operations. Designated critical habitat for North Atlantic right whale and North Pacific right whale are completely contained within the proposed OBIAs, and designated critical habitat for the remaining species identified above (Western DPS of Steller sea lions, Hawaiian monk seals, leatherback turtles, Northwest Atlantic DPS of loggerhead turtles, and Southern DPS of green sturgeon) are partially contained within the proposed OBIAs.

Given the proposed operational restrictions within these OBIAs and their complete overlap with North Atlantic and North Pacific right whale designated critical habitat, these habitats would only be exposed to low level (i.e., less than 180 dB re: 1 μPa [rms]) sounds from SURTASS LFA sonar. Similarly, portions of the remaining designated critical habitats would also only be exposed to low level (i.e., less than 180 dB re: 1 μPa [rms]) sounds from SURTASS LFA sonar. The remaining portions of Western DPS of Steller sea lion, Hawaiian monk seal, leatherback turtle, Northwest Atlantic DPS of loggerhead turtle, and Southern DPS of green sturgeon critical habitat could be fully exposed to SURTASS LFA sonar since SURTASS LFA sonar could actively be used in these areas. In addition, all designated critical habitat areas identified above could be exposed to general vessel operations since the proposed OBIAs only limit the operation of SURTASS LFA sonar and do not prohibit general vessel operations.

The above critical habitats contain a variety of physical and biological features deemed essential to the conservation of the ESA-species for which they were designated. Broadly speaking, these include waters free from obstruction; particular water properties including specific dissolved oxygen levels and temperatures, and low contaminants levels; specific water depths and sea states; oceanographic features such as currents and downwellings, benthic and algal features; and abundant prey. Possible stressors that may affect these physical and biological features associated with exposure to SURTASS LFA sonar routine training, testing, and military operations include vessel traffic, noise and discharge, operation of HF/M3 sonar equipment, and operation of both passive (SURTASS) and active (LFA) sonar equipment. However, as further outlined below, the effects of these stressors on the identified physical and biological features were determined to be either insignificant or discountable based on the nature of the feature and the stressor.

Vessel traffic, noise, and discharge is expected to have an insignificant effect on critical habitat physical and biological features. The Navy proposed to use a maximum of four vessels during SURTASS LFA sonar routine training, testing, and military operations.

Operation of vessels would result in a temporary increase of vessel traffic within designated critical habitat. This increase in vessel traffic is likely to consist of only one or two vessels, since it highly unlikely that all four SURTASS vessels would be operating simultaneously within a single critical habitat. The physical transit of vessels may result in brief obstruction of surface waters due to the presence of a vessel and slight changes in dissolved oxygen levels, water temperature, and currents due the vessels displacement and mixing of water, but is not expected to have any effect on contaminant levels, depth, benthic habitat, and sea state. It may also cause a slight change in distribution of prey and or algae. These effects would be highly localized, occurring only within close proximity to the transiting vessel, and temporary, with habitat conditions quickly returning pre exposure values once the vessel leaves the area. Given the localized and short-term nature of these effects, they are expect to have an insignificant effect on the physical and biological features of designated critical habitat. As such, we find that this stressor is not likely to adversely modify or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

Transiting vessels also produce a variety of sounds characterized as low-frequency, continuous, or tonal, with sound pressure levels at a source varying according to speed, burden, capacity, and length (Kipple and Gabriele 2007; McKenna et al. 2012; Richardson et al. 1995b). While such noise would not physically obstruct water passage or effect water properties, depth, sea state, or oceanographic, benthic and algal features, it may affect prey in designated critical habitat. However, as detailed previously in sections 4.2 through 4.5, that vast majority of fishes do not show strong responses to low frequency sound. In addition, we do not expect invertebrates to respond strongly to vessel sound (Albert 2011; Bennet et al. 1994). A study on the effects of vessel noise on sea hare (*Stylocheilus striatus*) found that chronic exposure to vessel noise may affect some invertebrate’s development and lead to increased mortality (Nedelec et al. 2014). However, the experimental conditions of this study are drastically different than the brief exposure to vessel noise that would result from SURTASS LFA vessel operations. Another recent study examining the effects of broadband sounds, including recorded continuous vessel noise, on three representative benthic invertebrates (the clam, *Ruditapes philippinarum*; the decapod, *Nephrops norvegicus*; and, the brittlestar, *Amphiura filiformis*) indicated that continued exposure to broadband sounds may affect benthic invertebrate behavior in ways that alter nutrient cycling (Solan et al. 2016). However, this study found no significant effects on invertebrate tissue biochemistry, and behavioral responses including avoidance behavior, were mixed (Solan et al. 2016). Importantly, this study examined time integrated effects, which differ from those that would result from the brief exposure to noise from a single, transiting vessel. While avoidance behavior in prey may lead to a change in distribution, any such change would be short-lived and likely not last much beyond when the vessel leaves the area. In addition, while at close ranges both fishes and invertebrates may experience injury from certain sound sources (Popper et al. 2014a; Sole et al. 2016), the injury or even loss of a few individual prey would not have a measurable impact on the overall prey abundance such that it would diminish the conservation value of critical habitat for ESA-listed species. Thus, the effects of vessel transit on designated critical habitat are insignificant. As a result, we find that this stressor is not likely to adversely modify or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

Finally, vessel discharge and pollution may occur as a result of SURTASS LFA sonar routine training, testing, and military operations. The International Convention for the Prevention of Pollution from Ships (MARPOL73/78) prohibits certain discharges of oil, noxious liquid substances, sewage, garbage, and air pollution from vessels within certain distances of the coastline. SURTASS LFA sonar vessels would operate in compliance with these requirements, but even with these measures an unintentional and intentional discharge of pollutants would occur. While such discharges may affect certain water quality properties, trigger harmful algal blooms, and temporarily affect distributions and behaviors of ESA-listed species and their prey, the size, duration, and localized extent of such discharges from only four vessels would likely be minor relative to the vast action area. Additionally, the Navy has instituted a “double-exchange” policy for surface vessel ballast tanks. All Navy surface vessels completely offload ballast water originating in a foreign port outside of 22 km (12 nmi) from shore and take on and discharge ‘clean sea water’ two times prior to entry within 22 km (12 nmi) of shore. The seawater then can be discharged within 22 km (12 nmi) of shore whenever ballast is no longer needed (E.P.A. 1999). This minimizes the likelihood that ballast water from SURTASS LFA sonar vessels will transfer invasive species. Therefore, the effects of vessel discharge and pollution are considered to be insignificant. As such, we find that this stressor is not likely to adversely modify or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

As a mitigation measure to reduce the exposure of marine mammals and sea turtles to SURTASS LFA sonar, the Navy proposes to operate the HF/M3 sonar continuously during the course of active SURTASS LFA sonar transmissions. The SURTASS LFA sonar and HF/M3 sonar system could be used in the coastal standoff zone or in the OBIAs; however, the sound source would not be above 180 dB and that restriction regarding OBIAs are only relevant during the effective period. Also, the HF/M3 system will be ramped-up. However, the HF/M3 system would not be used in areas where SURTASS LFA sonar would not occur, including the previously mentioned OBIAs and within the coastal stand-off distance. As such, the designated critical habitat that would be exposed to HF/M3 sonar is limited to those areas outside the OBIAs and beyond coastal standoff distance. Within these areas, operation of HF/M3 sonar may affect prey within designated critical habitat, but would not affect any other physical or biological feature previously identified. Nonetheless, the frequencies that would be used with HF/M3 sonar (30 to 40 kHz) are well above those frequencies at which fishes hear best (Ladich and Fay 2013). Furthermore, we do not expect such strong responses from invertebrates to such high frequency sounds, as invertebrates are thought to hear best at low frequencies (Hawkins and Popper 2016), and are regularly mapped using high frequency sonar (Fornshell and Tesei 2013), with no reports any related adverse impacts. Consequently, we find that effects resulting from the operation of HF/M3 sonar are extremely unlikely to occur, and as such, are discountable. Thus, we find that this stressor is not likely to adversely modify or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

Navy's use of SURTASS LFA sonar involves operation of both passive sonar components (SURTASS), and active sonar components (LFA). Given that operation of passive sonar components only involves the towing of passive acoustic equipment (i.e., hydrophone arrays), we do not expect effects to critical habitat beyond that which has already been described above for vessel transit. Thus, we find that the effects of operating the passive sonar components of SURTASS LFA are insignificant. As such, we find that this stressor is not likely to adversely modify or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

The operation of active sonar components of SURTASS LFA involves actively transmitting low frequency sounds in the marine environment. Like noise from vessels, such transmission would not physically obstruct water passage or effect water properties, depth, sea state, or oceanographic, benthic and algal features, but as further outlined below, it may affect prey in designated critical habitat. However, given Navy's proposed standoff distance and restricted use of SURTASS LFA sonar within the proposed OBIAs, in many areas we expect sounds originating from SURTASS LFA active sonar components would be reduced to negligible sound levels by the time they reach prey, due to transmission loss. Nonetheless, it is possible that active sonar components may be in operation within close proximity to prey within designated critical habitat outside these mitigation areas.

Studies using active acoustics indicate that sound sources could have indirect, adverse effects on marine animals by reducing the abundance or availability of prey or changing the structure or composition of the fish community. A number of investigators have suggested that fishes exposed to high intensity sounds could show a range of non-auditory injuries, extending from the cellular level to gross damage of the swim bladder and circulatory system (Popper and Hastings 2009a). However, the bulk of the data suggesting such injuries come from studies that tested the effects of explosives on fishes (Hastings and Carlson 2008; Popper and Hastings 2009a; Popper and Hastings 2009c; Yelverton et al. 1975). Similar results have been observed in fishes exposed to the impulsive sounds from pile driving when fishes are at an undetermined range but very close to the pile driving source (Abbott and Bing-Sawyer 2002; CalTrans 2004). There is no evidence for such damage when fishes are exposed to sounds similar to those produced by low-frequency sonars.

A few studies have examined the effects of SURTASS LFA sonar and seismic airguns on non-auditory tissues of fishes (Kane et al. 2010; Popper 2005; Popper et al. 2007). The consensus from these studies is that neither source, despite being very intense, had any effect on non-auditory tissues. In all fishes, the swimbladder was intact after exposure, and in the one study that involved an expert fish pathologist (to ensure that the non-auditory tissues of the fish sacrificed were examined properly), there was no damage to tissues either at the gross or cellular levels (Kane et al. 2010; Popper et al. 2007). These studies provide the first direct evidence that exposure to SURTASS LFA sonar is not likely to cause death or damage to fishes. However, it must be cautioned, as done by Hastings et al. (1996), McCauley et al. (2003), Popper et al. (2007), and Kastelein et al. (2008) (among others) that all studies to date encompass a very limited number of species and extrapolation among species and to other sound sources (or even to other levels or durations of the same sound sources), must be done with extreme caution, at least until there are more data upon which to base any extrapolations. Other studies have similarly found no mortality resulting from exposure to high intensity sounds (Hastings and Carlson 2008; Kane et al. 2010; McCauley et al. 2000; McCauley et al. 2003; Popper 2005; Popper et al. 2007). In contrast, one report by Turnpenny et al. (1994) suggested that sound exposure could produce substantial damage in caged fishes. However, reviews by subject matter experts found problems with this report and concluded that it did not appear to reflect the best available science on this issue.

In their *Sound Exposure Guidelines for Sea Turtles and Fishes*, a technical report developed and approved by Accredited Standards Committee S3/SC 1 Animal Bioacoustics, Popper et al. (2014b) concluded that the relative risk of a fish exhibiting a behavioral reaction in response to low-frequency sonar was low, regardless of the distance from the sound source. Additionally, the authors did not find any data on masking by sonar in fishes, but concluded that if it were to occur, masking would only occur in a narrow range of frequencies being masked by the sonar transmissions (Popper et al. 2014b).

A range of invertebrates are reported to be sensitive to low-frequency (10 to 150 Hz) hydroacoustic disturbances induced by sound waves or other sources – e.g., jellyfish, crustaceans, arrow worms, octopus, and squid (Albert 2011; Sole et al. 2016; Western Australian Department of Industry and Resources 2002). This sensitivity overlaps the frequency range of SURTASS LFA sonar (100 to 500 Hz), indicating that some mobile invertebrates could perceive SURTASS LFA sonar operations (Albert 2011; Sole et al. 2016; Western Australian Department of Industry and Resources 2002). Available studies report responses to airgun shots as being limited to transient alarm responses such as tail-flicks (lobsters) or siphon closing (ascidians) (Western Australian Department of Industry and Resources 2002), although mortality of giant squid in the Bay of Biscay may have been linked to seismic airgun activity in the area (Guerra et al. 2004). In addition, at least some jellyfish species appear to experience acoustic trauma as the result of exposure to low frequency sonar at frequencies between 50 to 400 Hz and at received levels up to 175 dB re: 1 µPa (rms) (Sole et al. 2016). We could find only one studying examining the effects of low frequency sounds on copepods, which documented no significant effects to copepod density, recruitment, and mortality (Bennet et al. 1994). McCauley et al. (2000b; 2000a) examined the effect of marine seismic surveys on captive squid and cuttlefish and reported a strong startle response or directed movement away from airguns during sudden, nearby start-ups at received levels of 174 dB re: 1 µPa (rms). Alarm responses in squid were detected during gradual ramp-up airguns once levels exceeded 156 to 161 dB re: 1 µPa (rms). Squid in these trials appeared to make use of the sound shadow measured near the water surface. These responses for captive squid suggest that behavioral changes and avoidance of operating airguns would likely occur. The authors concluded squid significantly alter their behavior at an estimated distance of two to five km (1.1 to 2.7 nmi) from an approaching large seismic source. A more recent study by Andre et al. (2011) exposed four species of squid and octopus in a tank to two hours of intense sounds. The authors reported tissue degeneration cause by the sounds. However, this study had substantial design and control problems and the results could have been attributed to those problems. Based on a review of airgun impacts on invertebrates by Christian and Bocking (2010), studies to date have not revealed any consistent evidence of serious pathological or physiological effects on invertebrates.

These studies indicate that exposure to low frequency sound has limited potential to affect fishes and invertebrates. Available evidence does not suggest low-frequency non-impulsive sound sources would typically be expected to cause morality or physiological damage. Additionally, as indicated by Popper et al. (2014b), the relative risk of a fish exhibiting a behavioral reaction in response to low-frequency sonar is low, regardless of the distance from the sound source. Though squid and some other invertebrates appear to exhibit alarm responses and avoidance of sound sources, individuals would be expected to resume normal behaviors immediately after initial exposure. We do not expect any such responses to have a measurable impact on the abundance of prey within designated critical habitat. Thus, we find that the effects of operating the active sonar components of SURTASS LFA are insignificant. As such, we find that this stressor is not likely to adversely affect, modify, or destroy designated critical habitat and we will not discuss effects from this stressor on designated critical habitat further.

In conclusion, with the proposed mitigations measures (stand-off distance and OBIAs), we find that stressors of vessel traffic, noise and discharge, operation of HF/M3 sonar equipment, and operation of both passive (SURTASS) and active (LFA) sonar equipment are not likely to adversely modify or destroy designated critical habitat for Southern DPS of green sturgeon, Hawaiian monk seals, leatherback turtles, Northwest Atlantic DPS of loggerhead turtles, North Atlantic right whales, North Pacific right whales, and Western DPS of Steller sea lions and as such, we will not discuss these designated critical habitats further.

5 STATUS OF ENDANGERED SPECIES ACT-LISTED SPECIES LIKELY TO BE

ADVERSELY AFFECTED BY THE PROPOSED ACTION

This section identifies and examines the status of each species under NMFS jurisdiction that may occur within the action area (as described in section 2.2) that may be adversely affected by the proposed action. These species are listed in Table 46, along with their regulatory status, designated critical habitat, and recovery plan. It then summarizes the biology and ecology of those species and what is known about their life histories. The status is determined by the 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" as described in 50 CFR §402.02. More detailed information on the status and trends of these ESA-listed species, and their biology and ecology can be found in the listing regulations and critical habitat designations published in the *Federal Register*, status reviews, recovery plans, and on these NMFS websites: (http://www.nmfs.noaa.gov/pr/species/index.htm), among others.

Table 46. Threatened and endangered species that are likely be adversely affected by the proposed action.

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Marine Mammals – Cetaceans				
Blue Whale (*Balaenoptera musculus)*	E – 35 FR 18319	-- --	07/1998 Intent to update (77 FR 22760)	LAA/LAA
Bowhead Whale (*Balaena mysticetus*)	E – 35 FR 18319	-- --	-- --	LAA/LAA
Bryde's Whale (*Balaenoptera edeni*) – Gulf of Mexico Sub-species	PE – 81 FR 88639	-- --	-- --	NLAA/LAA
False Killer Whale (*Pseudorca crassidens*) – Main Hawaiian Islands Insular DPS	E – 77 FR 70915	-- --	-- --	LAA/LAA
Fin Whale (*Balaenoptera physalus)*	E – 35 FR 18319	-- --	07/2010 75 FR 47538	LAA/LAA
Gray Whale (*Eschrichtius robustus*) – Western North Pacific Population	E – 35 FR 18319; Eastern North Pacific population was delisted in 1994 – 59 FR 31094	-- --	-- --	LAA/LAA
Humpback Whale (*Megaptera novaeangliae*)		-- --	11/1991 55 FR 29646	LAA/LAA – All DPSs
- Arabian Sea DPS	E – 81 FR 62259			
- Cape Verde/Northwest Africa DPS	E – 81 FR 62259			
- Central America DPS	E – 81 FR 62259			
- Mexico DPS	T – 81 FR 62259			
- Western North Pacific DPS	E – 81 FR 62259			

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Killer Whale (*Orcinus orca*) – Southern Resident DPS	E – 70 FR 69903	71 FR 69054	01/2008 73 FR 4176	NLAA/LAA
North Atlantic Right Whale (*Eubalaena glacialis*)	E – 35 FR 18319 73 FR 12024	59 FR 28805 81 FR 4837	08/2004 70 FR 32293	LAA/LAA
North Pacific Right Whale (*Eubalaena japonica*)	E – 35 FR 18319 73 FR 12024	73 FR 19000	06/2013 78 FR 34347	LAA/LAA
Sei Whale (*Balaenoptera borealis*)	E – 35 FR 18319	-- --	12/2011 76 FR 43985	LAA/LAA
South Island Hector's Dolphin (*Cephalorhynchus hectori hectori*)	PT – 81 FR 64110	-- --	-- --	NLAA/LAA
Southern Right Whale (*Eubalaena australis*)	E – 35 FR 8491	-- --	-- --	LAA/LAA
Sperm Whale (*Physeter macrocephalus*)	E – 35 FR 18319	-- --	12/2010 75 FR 81584	LAA/LAA
Marine Mammals – Pinnipeds				
Bearded Seal (*Erignathus barbatus*) – Okhotsk DPS	T – 77 FR 76739	-- --	-- --	LAA/LAA
Guadalupe Fur Seal (*Arctocephalus philippii townsendi*)	T – 50 FR 51252	-- --	-- --	LAA/LAA
Hawaiian Monk Seal (*Neomonachus schauinslandi*)	E – 41 FR 51611	51 FR 16047 53 FR 18988 80 FR 50925	03/1983 08/2007 72 FR 46966	LAA/LAA
Mediterranean Monk Seal (*Monachus monachus*)	E – 35 FR 8491	-- --	-- --	LAA/LAA
Ringed Seal (*Phoca hispida hispida*) – Arctic DPS	T – 77 FR 76705 *Vacated by Court, Appeal Pending*	79 FR 73010	-- --	NLAA/LAA
Ringed Seal (*Phoca hispida ochotensis*) – Okhotsk DPS	T – 77 FR 76705	-- --	-- --	LAA/LAA
Spotted Seal (*Phoca largha*) – Southern DPS	T – 75 FR 65239	-- --	-- --	LAA/LAA
Steller Sea Lion (*Eumetopias jubatus*) – Western DPS	E – 55 FR 49204 62 FR 24345	58 FR 45269	12/1992 03/2008	LAA/LAA

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Sea Turtles				
Green Sea Turtle (*Chelonia mydas*)		63 FR 46693 – Culebra Island, Puerto Rico	10/1991 – Atlantic 05/1998 – Pacific 05/1998 – East Pacific 63 FR 28359	NLAA/LAA – All DPSs
- North Atlantic DPS	T – 81 FR 20057			
- Mediterranean DPS	E – 81 FR 20057			
- South Atlantic DPS	T – 81 FR 20057			
- Southwest Indian DPS	T – 81 FR 20057			
- North Indian DPS	T – 81 FR 20057			
- East Indian-West Pacific DPS	T – 81 FR 20057			
- Central West Pacific DPS	E – 81 FR 20057			
- Southwest Pacific DPS	T – 81 FR 20057			
- Central South Pacific DPS	E – 81 FR 20057			
- Central North Pacific DPS	T – 81 FR 20057			
- East Pacific DPS	T – 81 FR 20057			
Hawksbill Sea Turtle (*Eretmochelys imbricata)*	E – 35 FR 8491	63 FR 46693 – Mona and Monita Islands, Puerto Rico	08/1992 – U.S. Caribbean, Atlantic, and Gulf of Mexico 57 FR 38818 05/1998 – U.S. Pacific 63 FR 28359	NLAA/LAA
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	E – 35 FR 18319	-- --	08/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 76 FR 58781 09/2011	NLAA/LAA
Leatherback Sea Turtle (*Dermochelys coriacea*)	E – 35 FR 8491	44 FR 17710 – Sandy Point, St. Croix, U.S. Virgin Islands 77 FR 4170 – U.S. West Coast	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 63 FR 28359	NLAA/LAA

Species	ESA Status	Critical Habitat	Recovery Plan	Navy/NMFS Determination
Loggerhead Sea Turtle (*Caretta caretta*)		79 FR 39856	10/1991 – U.S. Caribbean, Atlantic, and Gulf of Mexico 05/1998 – U.S. Pacific 63 FR 28359 01/2009 – Northwest Atlantic 74 FR 2995	NLAA/LAA – All DPSs
- Mediterranean Sea DPS	E – 76 FR 58868			
- Northeast Atlantic Ocean DPS	E – 76 FR 58868			
- Northwest Atlantic Ocean DPS	T – 76 FR 58868			
- North Indian Ocean DPS	E – 76 FR 58868			
- North Pacific Ocean DPS	E – 76 FR 58868			
- South Atlantic Ocean DPS	T – 76 FR 58868			
- South Pacific Ocean DPS	E – 76 FR 58868			
- Southeast Indo-Pacific Ocean DPS	T – 76 FR 58868			
- Southwest Indian Ocean DPS	T – 76 FR 58868			
Olive Ridley Sea Turtle (*Lepidochelys olivacea*)		-- --	05/1998 – U.S. Pacific 63 FR 28359	NLAA/LAA
- Breeding Populations on the Pacific Coast of Mexico	E – 43 FR 32800			
- All Other Populations	T – 43 FR 32800			

E=Endangered
T=Threatened
PE=Proposed Endangered
PT=Proposed Threatened
DPS=Distinct Population Segment
ESU=Evolutionary Significant Unit
NE=No Effect
NLAA=Not Likely to Adversely Affect
LAA=Likely to Adversely Affect

5.1 Blue Whale

The blue whale is a widely distributed baleen whale found in all major oceans (Figure 8).

Figure 8. Map identifying the range of the endangered blue whale.

Blue whales are the largest animal on earth and distinguishable from other whales by a long-body and comparatively slender shape, a broad, flat "rostrum" when viewed from above, proportionally smaller dorsal fin, and are a mottled gray color that appears light blue when seen through the water. Most experts recognize at least three subspecies of blue whale, *B. m. musculus*, which occurs in the Northern Hemisphere, *B. m. intermedia*, which occurs in the Southern Ocean, and *B. m. brevicauda*, a pygmy species found in the Indian Ocean and South Pacific Ocean. The blue whale was originally listed as endangered on December 2, 1970 (Table 46).

Information available from the recovery plan (NMFS 1998), recent stock assessment reports (Carretta et al. 2017; Hayes et al. 2017; Muto et al. 2017), and status review (COSEWIC 2002) were used to summarize the life history, population dynamics, and status of the species as follows.

Life History

The average life span of blue whales is 80 to 90 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 kg (7,936.6 lb) daily. Feeding aggregations are often found at the continental shelf edge, where upwelling produces concentrations of krill at depths of 90 to 120 m (295.3 to 393.7 ft).

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 2007). Current estimates indicate approximately 5,000 to 12,000 blue whales globally (IWC 2007). Blue whales are separated into populations by ocean basin in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere. There are three stocks of blue whales designated in U.S. waters: the Eastern North Pacific Ocean (current best estimate N=1,647, N_{min}=1,551; (VanBlaricom et al. 1993)), Central North Pacific Ocean (N=81, N_{min}=38), and Western North Atlantic Ocean (N=400 to 600, N_{min}=440). In the Southern Hemisphere, the latest abundance estimate for Antarctic blue whales is 2,280 individuals in 1997/1998 (95 percent confidence intervals 1,160 to 4,500 (Branch 2007). While no rangewide estimate for pygmy blue whales exists (Thomas et al. 2016), the latest estimate for pygmy blue whales off the west coast of Australia is 662 to 1,559 individuals based on passive acoustic monitoring (McCauley and Jenner 2010), or 712 to 1,754 individuals based on photographic mark-recapture (Jenner et al. 2008).

Current estimates indicate a growth rate of just under three percent per year for the eastern North Pacific stock (Calambokidis et al. 2009). An overall population growth rate for the species or growth rates for the two other individual U.S. stocks are not available at this time. In the Southern Hemisphere, population growth estimates are available only for Antarctic blue whales, which estimate a population growth rate of 8.2 percent per year (95 percent confidence interval 1.6 to 14.8 percent) (Branch 2007).

Little genetic data exist on blue whales globally. Data from Australia indicates that at least populations in this region experienced a recent genetic bottleneck, likely the result of commercial whaling, although genetic diversity levels appear to be similar to other, non-threatened mammal species (Attard et al. 2010). Consistent with this, data from Antarctica also demonstrate this bottleneck but high haplotype diversity, which may be a consequence of the recent timing of the bottleneck and blue whales long lifespan (Sremba et al. 2012). Data on genetic diversity of blue whales in the Northern Hemisphere are currently unavailable. However, genetic diversity information for similar cetacean population sizes can be applied. Stocks that have a total population size of 2,000 to 2,500 individuals or greater provide for maintenance of genetic diversity resulting in long-term persistence and protection from substantial environmental variance and catastrophes. Stocks that have a total population of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Stock population 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 (Figure 8). In the North Atlantic Ocean, the blue whale range extends form the subtropics to the Greenland Sea. They are most frequently sighted in waters of eastern Canada with a majority of sightings taking place in the Gulf of St. Lawrence. In the North Pacific Ocean, blue whales range from Kamchatka to southern Japan in the west and from the Gulf of Alaska and California to Costa Rica in the east. They primarily occur off the Aleutian Islands and the Bering Sea. In the northern Indian Ocean, there is a “resident” population of blue whales with sightings being reported from the Gulf of Aden, Persian Gulf, Arabian Sea, and across the Bay of Bengal to Burma and the Strait of Malacca. In the Southern Hemisphere, distributions of subspecies can be segregated. The subspecies *B. m. intermedia* occurs in relatively high latitudes south of the “Antarctic Convergence” (located between 48 and 61° South latitude) and close to the ice edge. The subspecies *B. m. brevicauda* is typically distributed north of the Antarctic Convergence.

Vocalization and Hearing

Blue whales produce prolonged low-frequency vocalizations that include moans in the range from 12.5 to 400 Hz, with dominant frequencies from 16 to 25 Hz, and songs that span frequencies from 16 to 60 Hz that last up to 36 seconds repeated every one to two minutes (see McDonald et al. 1995). Berchok et al. (2006a) examined vocalizations of St. Lawrence blue whales and found mean peak frequencies ranging from 17 to 78.7 Hz. Reported source levels are 180 to 188 dB re: 1 µPa, but may reach 195 dB re: 1 µPa (Aburto et al. 1997; Clark and Gagnon 2004; Ketten 1998; McDonald et al. 2001a). Samaran et al. (2010) estimated Antarctic blue whale calls in the Indian Ocean at 179 ± 5 dB re: 1 µPa (rms) at 1 m in the 17 to 30 Hz range and pygmy blue whale calls at 175 ± 1 dB re: 1 µPa (rms) at 1 m in the 17 to 50 Hz range.

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

Cetaceans have an auditory anatomy that follows the basic mammalian pattern, with some modifications to adapt to the demands of hearing in the sea. The typical mammalian ear is divided into the outer ear, middle ear, and inner ear. The outer ear is separated from the inner ear by the tympanic membrane, or eardrum. In terrestrial mammals, the outer ear, eardrum, and middle ear function to transmit airborne sound to the inner ear, where the sound is detected in a fluid. Since cetaceans already live in a fluid medium, they do not require this matching, and thus do not have an air-filled external ear canal. The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997b) hypothesized that large mysticetes have acute infrasonic hearing.

Blue whale vocalizations tend to be long (greater than 20 seconds), low frequency (less than 100 Hz) signals (Thomson and Richardson 1995a), with a range of 12 to 400 Hz and dominant energy in the infrasonic range of 12 to 25 Hz (Ketten 1998; McDonald et al. 2001b; Mellinger and Clark 2003). Vocalizations are predominantly songs and calls. Blue whale calls have high acoustic energy, with reports of 186 to 188 dB re: 1 µPa-m (Cummings and Thompson 1971b; McDonald et al. 2001b) and 195 dB re: 1 µPa-m (Aburto et al. 1997) source levels. Calls are short-duration sounds (two to five seconds) that are transient and frequency-modulated, having a higher frequency range and shorter duration than song units and often sweeping down in frequency (80 to 30 Hz), with seasonally variable occurrence.

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

Although general characteristics of blue whale calls are shared in distinct regions (McDonald et al. 2001b; Mellinger and Clark 2003; Rankin et al. 2005; Thompson et al. 1996), some variability appears to exist among different geographic areas (Rivers 1997). Sounds in the North Atlantic Ocean have been confirmed to have different characteristics (i.e., frequency, duration, and repetition) than those recorded in other parts of the world (Berchok et al. 2006b; Mellinger and Clark 2003). Clear differences in call structure suggestive of separate populations for the western and eastern regions of the North Pacific Ocean have also been reported (Stafford et al. 2001); however, some overlap in calls from the geographically distinct regions have been observed, indicating that the whales may have the ability to mimic calls (Stafford and Moore 2005).

In Southern California, blue whales produce two predominant call types: Type B and D. B calls are stereotypic of blue whale population found in the eastern North Pacific (McDonald et al. 2006b) and are produced exclusively by males and associated with mating behavior (Oleson et al. 2007a). These calls have long durations (20 seconds) and low frequencies (10 to 100 Hz); they are produced either as repetitive sequences (song) or as singular calls. The B call has a set of harmonic tonals, and may be paired with a pulsed Type A call. Blue whale D calls are down-swept in frequency (100 to 40 Hz) with duration of several seconds. These calls are similar worldwide and are associated with feeding animals; they may be produced as call-counter-call between multiple animals (Oleson et al. 2007b). In the SOCAL Range Complex region, D call are produced in highest numbers during the late spring and early summer, and in diminished numbers during the fall, when A-B song dominates blue whale calling (Hildebrand et al. 2011; Hildebrand et al. 2012; Oleson et al. 2007c).

Calling rates of blue whales tend to vary based on feeding behavior. Stafford et al. (2005) recorded the highest calling rates when blue whale prey was closest to the surface during its vertical migration. Wiggins et al. (2005) reported the same trend of reduced vocalization during daytime foraging followed by an increase at dusk as prey moved up into the water column and dispersed. Blue whales make seasonal migrations to areas of high productivity to feed, and vocalize less at the feeding grounds then during migration (Burtenshaw et al. 2004). Oleson et al. (2007c) reported higher calling rates in shallow diving (less than 30 m [100 ft] whales, while deeper diving whales (greater than 50 m [165 ft]) were likely feeding and calling less.

Direct studies of blue whale hearing have not been conducted, but it assumed that blue whales can hear the same frequencies that they produce (low frequency) and are likely most sensitive to this frequency range (Ketten 1997a; Richardson et al. 1995e). Based on vocalizations and anatomy, blue whales are assumed to predominantly hear low-frequency sounds below 400 Hz (Croll et al. 2001; Oleson et al. 2007c; Stafford and Moore 2005). In terms of functional hearing capability, blue whales belong to the low frequency group, which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007).

Status

The blue whale is endangered as a result of past commercial whaling. In the North Atlantic Ocean, at least 11,000 blue whales were taken from the late nineteenth to mid-20th centuries. 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 populations appear to be increasing in size, the species appears to be somewhat resilient to current threats; however, the species has not recovered to pre-exploitation levels.

Critical Habitat

No critical habitat has been designated for the blue whale.

Recovery Goals

See the 1998 *Final Recovery Plan for the Blue Whal*e for complete downlisting/delisting criteria for each of the following recovery goals.

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

5.2 Bowhead Whale

The bowhead whale is a circumpolar baleen whale found throughout high latitudes in the Northern Hemisphere (Figure 9).

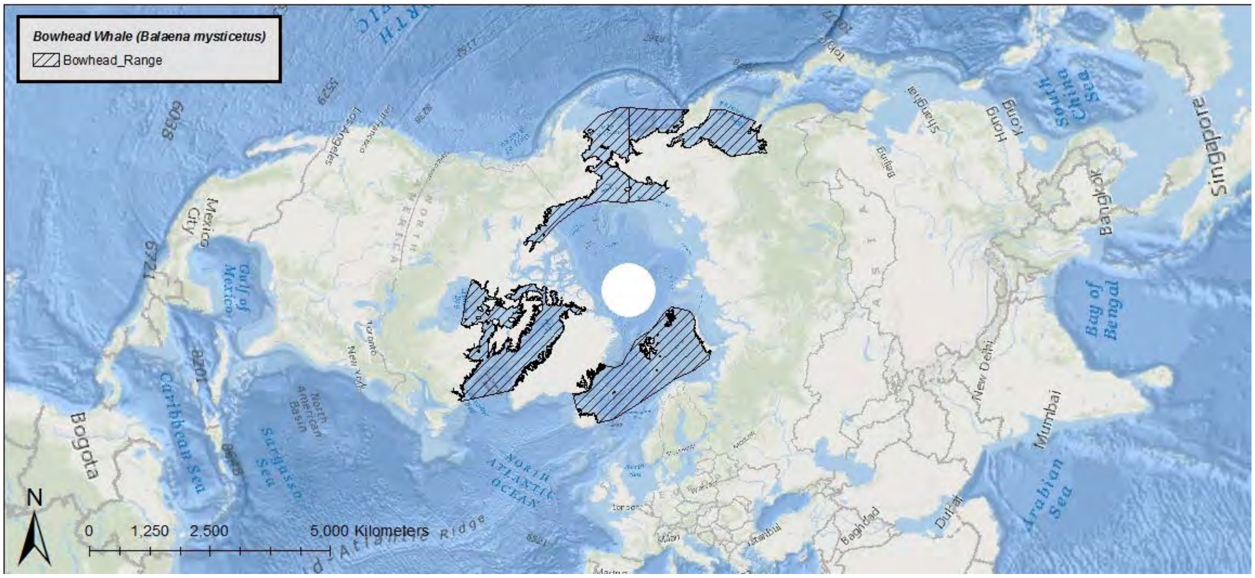

Figure 9. Map identifying the range of the endangered bowhead whale.

Bowheads are baleen whales distinguishable from other whales by a dark body with a distinctive white chin, no dorsal fin, and a bow-shaped skull that takes up about 35 percent of their total body length. The bowhead whale was originally listed as endangered on December 2, 1970 (Table 46).

Information available from the recent stock assessment report (Muto et al. 2017) and the scientific literature was used to summarize the life history, population dynamics, and status of the species as follows.

Life History

The average lifespan of bowhead whales is unknown; however, some evidence suggests that they can live for over one hundred years. They have a gestation period of 13 to 14 months and it is unknown how long calves nurse. Sexual maturity is reached around twenty years of age with an average calving interval of three to four years. They spend the winter associated with the southern limit of the pack ice and move north as the sea ice breaks up and recedes during spring. Bowhead whales use their large skulls to break through thick ice and feed on zooplankton (crustaceans like copepods, euphausiids, and mysids), other invertebrates, and fish.

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 bowhead whale.

The global, pre-exploitation estimate for bowhead whales is 30,000 to 50,000 animals. There are currently four or five recognized stocks of bowhead whales, the Western Arctic (or Bering-Chukchi-Beaufort) stock, the Okhotsk Sea stock, the Davis Strait and Hudson Bay stock (sometimes considered separate stocks), and the Spitsbergen stock (Rugh and Shelden 2009). The only stock thought to be found within U.S. waters is the Western Arctic stock. The 2011 ice-based abundance estimate puts this stock, the largest remnant stock, at over 16,892 (N_{min}=16,091) individuals. Prior to commercial whaling, there may have been 10,000 to 23,000 whales in this stock (Rugh and Shelden 2009). Historically the Davis Strait and Hudson Bay stock may have contained over 11,000 individuals, but now it is thought to number around 7,000 bowhead whales (Cosens et al. 2006). In the Okhotsk Sea, there were originally more than 3,000 bowhead whales, but now there are only about 300 to 400. The Spitsbergen stock originally had about 24,000 bowhead whales and supported a huge European fishery, but today is thought to only contain tens of whales (Shelden and Rugh 1995).

Current estimates indicate approximately 16,892 (N_{min}=16,091) bowhead whales in the Western Arctic stock, with an annual growth rate of 3.7 percent (Givens et al. 2013). While no quantitative estimates exist, the Davis Strait and Hudson Bay stock is also thought to be increasing (COSEWIC 2009). We could find no information on population trends for the Okhotsk Sea stock. Likewise, no information is available on the population trend for the Spitsbergen stock, but it is thought to be nearly extinct.

Genetic studies conducted on the Western Arctic stock of bowhead whales revealed 68 different haplotypes defined by 44 variable sites (Leduc et al. 2008) making it the most diverse stock of bowhead whales. These results are consistent with a single stock with genetic heterogeneity related to age cohorts and indicate no historic genetic bottlenecks (Rugh et al. 2003). In the

Okhotsk Sea stock, only four to seven mitochondrial DNA haplotypes have been identified, three of which are shared with the Western Arctic stock, indicating lower genetic diversity, as might be expected given its much smaller population size (Alter et al. 2012; LeDuc et al. 2005; MacLean 2002). The Davis Strait and Hudson Bay stock has 23 mitochondrial DNA haplotypes, making it more diverse than the Okhotsk stock but less diverse than the large Western Arctic stock (Alter et al. 2012). Based on historic mitochondrial DNA, the Spitsbergen stock previously had at least 58 mitochondrial DNA haplotypes, but its current genetic diversity remains unknown (Borge et al. 2007). However, given its near extirpation, it likely has low genetic diversity.

The Western Arctic stock is found in waters around Alaska, the Okhotsk Sea stock in eastern Russia waters, the Davis Strait and Hudson Bay stock in northeastern waters near Canada, and the Spitsbergen stock in the northeastern Atlantic (Rugh and Shelden 2009) (Figure 8).

Vocalization and Hearing

Bowhead whales produce songs of an average source level of 185±2 dB re: 1 µPa at 1 m (rms) centered at a frequency of 444±48 Hz (Roulin et al. 2012). Given background noise, this allows bowhead whales an active space of 40 to 130 km (21.6 to 70.2 nmi) (Roulin et al. 2012). We are aware of no information directly on the hearing abilities of bowhead whales, but all marine mammals, we presume they hear best in frequency ranges at which they produce sounds (444±48 Hz).

Status

The bowhead whale is endangered as a result of past commercial whaling. Prior to commercial whaling, thousands of bowhead whales existed. Global abundance declined to 3,000 by the 1920's. Bowhead whales may be killed under "aboriginal subsistence whaling" provisions of the International Whaling Commission. Additional threats include ship strikes, fisheries interactions (including entanglement), contaminants, and noise. The species' large population size and increasing trends indicate that it is resilient to current threats.

Critical Habitat

No critical habitat has been designated for the bowhead whale.

Recovery Goals

Currently, there is no recovery plan available for the bowhead whale.

5.3 Bryde's Whale – Gulf of Mexico Sub-Species

The Bryde's whale is a widely distributed baleen whale found in tropical and subtropical oceans. The Gulf of Mexico sub-species of Bryde's whale is found in the northeastern Gulf of Mexico near De Soto Canyon (Figure 10). From historical whaling records and several recent sightings, there some evidence of a former distribution of these whales in waters of north-central and southern Gulf of Mexico.

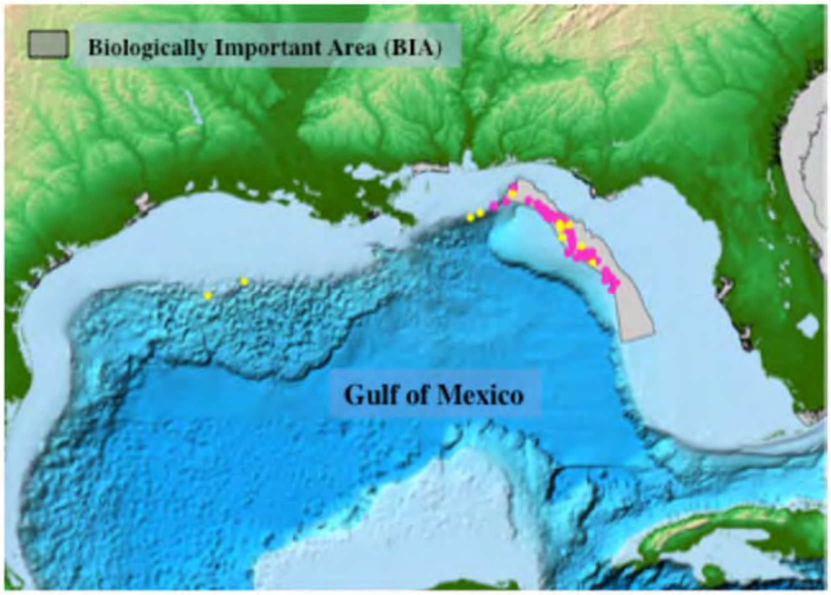

Figure 10. Map identifying the biologically important area and known range of the proposed endangered Gulf of Mexico sub-species of Bryde's whale (Rosel 2016).

Bryde's whales are baleen whales that grow to lengths of 13 to 16.5 m (42.7 to 54.1 ft). Bryde's whales in the Gulf of Mexico are a taxonomically distinct sub-species. Gulf of Mexico sub-species of Bryde's whales have a gray dorsal surface, streamlined body, and pointed, flat rostrum with three prominent ridges. The Gulf of Mexico sub-species of Bryde's whale was proposed for listing under the ESA as endangered on December 8, 2016 (Table 46).

Information available from the status review (Rosel 2016), the proposed listing, recent stock assessment report (Hayes et al. 2017), and available literature were used to summarize the life history, population dynamics, and status of the species as follows.

Life History

The life expectancy of Gulf of Mexico sub-species of Bryde's whales is unknown. They have a gestation period of 11 to 12 months, give birth to a single calf, which is nursed for six to 12 months. Age of sexual maturity is not known for Gulf of Mexico sub-species Bryde's whales specifically, but Bryde's whales are thought to be sexually mature at eight to 13 years. Peak breeding and calving probably occurs in the fall. Females breed every second year. Gulf of Mexico sub-species of Bryde's whales exhibit a typical diel dive pattern, with deep dives in the daytime, and shallow dives at night. Bryde's whales generally feed on schooling fishes (e.g., anchovy, sardine, mackerel, and herring) and small crustaceans (Rosel 2016).

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 Gulf of Mexico sub-species Bryde's whale.

The Gulf of Mexico sub-species of Bryde's whale population is very small; the most recent estimate from 2009 places the population size at 33 individuals (N_{min}=16). A second estimate incorporating visual survey data from 1992 to 2009 estimated 44 individuals (Rosel 2016). There is no population trend information available for the Gulf of Mexico sub-species of Bryde's whale.

Genetic diversity within the Gulf of Mexico sub-species of Bryde's whale population is very low, with genetic analyses indicating only two mitochondrial DNA haplotypes (compared to five haplotypes for North Atlantic right whales and 51 in fin whales across the same control region sequence) (Rosel and Wilcox 2014). Examination of 42 nuclear microsatellite loci found that 60 percent were monomorphic, meaning no genetic variability was seen for the 21 Gulf of Mexico sub-species of Bryde's whales sampled (Rosel 2016).

The range of Gulf of Mexico sub-species of Bryde's whales is primarily in a small, biologically important area in the northeastern Gulf of Mexico near De Soto Canyon, in waters 100 to 400 m (328 to 1,312 ft) deep along the continental shelf break. It inhabits the Gulf of Mexico year round, but its distribution outside of this biologically important area is unknown.

Vocalization and Hearing

Bryde's whales produce low-frequency tonal and broadband calls for communication, navigation, and reproduction (Richardson et al. 1995a). Like other balaenopterids, Bryde's whales have distinctive calls depending on geographic regions (Figueiredo 2014; Patricia E. Rosel 2016; Širović et al. 2014). In areas of the Gulf of Mexico where Bryde's whales are thought to be the main baleen whale present, a variety of vocalizations consistent with Bryde's whale vocalizations from other locations have been recorded ranging in frequency from 43 to 208 Hz (Rice et al. 2014). While no data exist on the hearing abilities of Bryde's whale, as with other marine mammals we assume they hear best in the frequency range in which they produce calls.

Status

Historically, commercial whaling did occur in the Gulf of Mexico, but the area was not considered prime whaling grounds. Bryde's whales were not specifically targeted by commercial whalers, but the "finback whales" which were caught between the mid-1700s and late 1800s were likely Bryde's whales (Reeves et al. 2011). Noise from shipping traffic and seismic surveys in the region may impact Gulf of Mexico sub-species of Bryde's whales' ability to communicate. Vessel traffic from commercial shipping and the oil and gas industry also poses a risk of vessel strike for Gulf of Mexico sub-species of Bryde's whales. Entanglement from fishing gear is also a threat, and several fisheries operate within the range of the species. The Deepwater Horizon oil spill severely impacted Bryde's whales in the Gulf of Mexico, with an estimated 17 percent of the population killed, 22 percent of females exhibiting reproductive failure, and 18 percent of the population suffering adverse health effects (DWHTrustees 2016). Because the Gulf of Mexico sub-species of Bryde's whale population is so small size and has low genetic diversity, it is highly susceptible to further perturbations.

Critical Habitat

No critical habitat has been designated for Gulf of Mexico sub-species of Bryde's whales as the species is currently proposed for listing under the ESA.

Recovery Goals

No Recovery Plan has been prepared for the Gulf of Mexico sub-species of Bryde's whales as the species is currently proposed for listing under the ESA.

5.4 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 (3,281 ft) deep. The Main Hawaiian Islands Insular DPS of false killer whales is found in waters around the Main Hawaiian Islands (Figure 11).

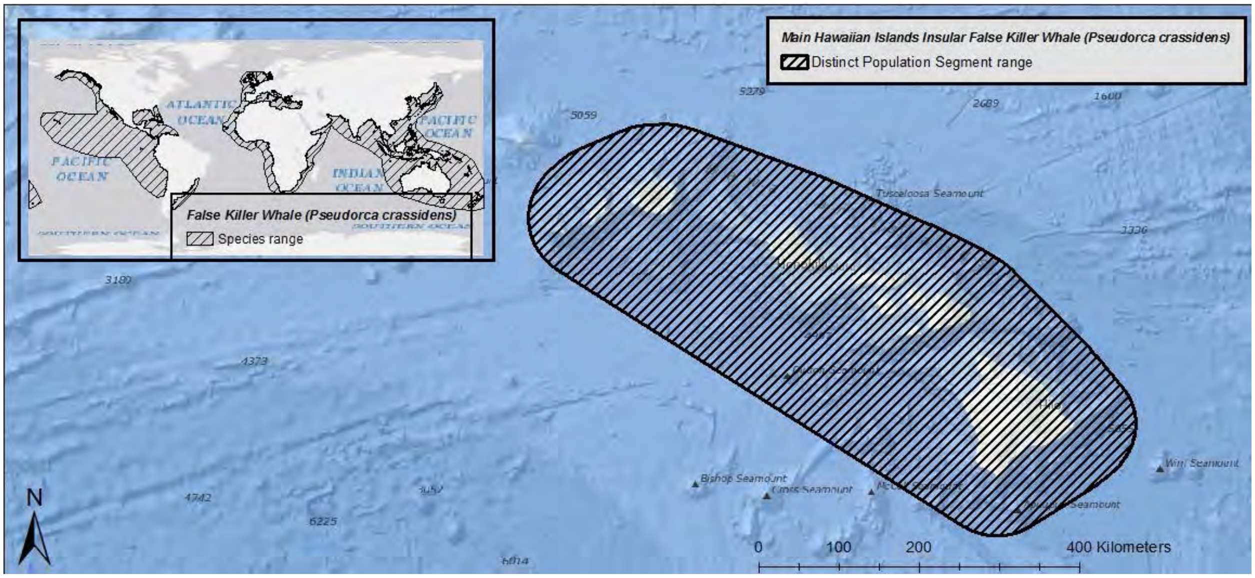

Figure 11. Map identifying the range of false killer whales and the endangered Main Hawaiian Islands Insular distinct population segment of false killer whale.

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 (Table 46).

Information available from the most recent status review (NMFS 2010d) and recent stock assessment (Carretta et al. 2017) were used to summarize the status of the species as follows.

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 (3,281 ft). 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.

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. 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 92 false killer whales (Baird et al. 2015).

A current estimated population growth rate for the Main Hawaiian Islands Insular DPS of false killer whales is not available at this time. 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. 2012). 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 Ocean.

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 (21.6 nmi) of the Main Hawaiian Islands belong to the insular stock and all false killer whales beyond 140 km (75.6 nmi) 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.

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. 2007). 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. 2007) with source levels in the range of 100 to 170 dB re: 1 µPa (see (Richardson et al. 1995e)). 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 µPa 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).

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).

Critical Habitat

No critical habitat has been designated for the Main Hawaiian Islands Insular DPS of the false killer whale.

Recovery Goals

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

5.5 Fin Whale

The fin whale is a large, widely distributed baleen whale found in all major oceans and comprised of three subspecies: *B. p. physalus* in the Northern Hemisphere, and *B. p. quoyi* and *B. p. patachaonica* (a pygmy form) in the Southern Hemisphere (Figure 12).

Figure 12. Map identifying the range of the endangered fin whale.

Fin whales are distinguishable from other whales by a sleek, streamlined body, with a V-shaped head, a tall falcate dorsal fin, and a distinctive color pattern of a black or dark brownish-gray body and sides with a white ventral surface. The lower jaw is gray or black on the left side and creamy white on the right side. The fin whale was originally listed as endangered on December 2, 1970 (Table 46).

Information available from the recovery plan (NMFS 2010c), recent stock assessment reports (Carretta et al. 2017; Hayes et al. 2017; Muto et al. 2017), and status review (NMFS 2011b) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Fin whales can live, on average, 80 to 90 years. They have a gestation period of less than one year, and calves nurse for six to seven months. Sexual maturity is reached between six and 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, although some fin whales appear to be residential to certain areas. Fin whales eat pelagic crustaceans (mainly euphausiids or krill) and schooling fish such as capelin, herring, and sand lice.

Population Dynamics

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

The pre-exploitation estimate for the fin whale population in the North Pacific Ocean was 42,000 to 45,000 (Ohsumi and Wada 1974). In the North Atlantic Ocean, at least 55,000 fin whales were killed between 1910 and 1989. Approximately 704,000 fin whales were killed in the Southern Hemisphere from 1904 to 1975. Of the three to seven stocks in the North Atlantic Ocean (approximately 50,000 individuals), one occurs in U.S. waters, where the best estimate of abundance is 1,618 individuals (N_{min}=1,234); however, this may be an underrepresentation as the entire range of stock was not surveyed (Palka 2012). There are three stocks in U.S. Pacific Ocean waters: Northeast Pacific [minimum 1,368 individuals], Hawaii (approximately 58 individuals [N_{min}=27]) and California/Oregon/Washington (approximately 9,029 [N_{min}=8,127] individuals) (Nadeem et al. 2016) . The IWC also recognizes the China Sea stock of fin whales, found in the Northwest Pacific Ocean, which currently lacks an abundance estimate (Reilly et al. 2013). Abundance data for the Southern Hemisphere stock are limited; however, there were assumed to be somewhat more than 15,000 in 1983 (Thomas et al. 2016).

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

Archer et al. (2013) recently examined the genetic structure and diversity of fin whales globally. Full sequencing of the mitochondrial DNA genome for 154 fin whales sampled in the North Atlantic Ocean, North Pacific Ocean, and Southern Hemisphere, resulted in 136 haplotypes, none of which were shared among ocean basins suggesting differentiation at least at this geographic scale. However, North Atlantic fin whales appear to be more closely related to the

Southern Hemisphere population, as compared to fin whales in the North Pacific Ocean, which may indicate a revision of the subspecies delineations is warranted. Generally speaking, haplotype diversity was found to be high both within oceans 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 Ocean, North Pacific Ocean, and Southern Hemisphere where they appear to be reproductively isolated. The availability of prey, sand lice in particular, is thought to have had a strong influence on the distribution and movements of fin whales.

Vocalization and Hearing

Fin whales produce a variety of low frequency sounds in the 10 to 200 Hz range (Edds 1988; Thompson et al. 1992; Watkins 1981; Watkins et al. 1987). Typical vocalization 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 (Clark et al. 2002; Patterson and Hamilton 1964). Richardson et al. (1995e) 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 in winter. Au (Au and Green 2000b) reported monas 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 μPa-m (see also Clark and Gagnon 2004; as compiled by Erbe 2002b). The source depth of calling fin whales has been reported to be about 50 m (164 ft) (Watkins et al. 1987).

Although their function is still in doubt, low frequency fin whale vocalizations travel over long distances and may aid in long distance communication (Edds-Walton 1997; Payne and Webb. 1971). During the breeding season, fin whales produce pulses in a regular repeating pattern, which have been proposed to be mating displays similar to those of humpback whales (Croll et al. 2002). These vocal bouts last for a day or longer (Tyack 1999).

The inner ear is where sound energy is converted into neural signals that are transmitted to the central nervous system via the auditory nerve. Acoustic energy causes the basilar membrane in the cochlea to vibrate. Sensory cells at different positions along the basilar membrane are excited by different frequencies of sound (Tyack 1999). Baleen whales have inner ears that appear to be specialized for low frequency hearing. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997b) hypothesized that large mysticetes have acute infrasonic hearing. In a study using computer tomography scans of a calf fin whale skull, Cranford and Krysl (2015) found sensitivity to a broad range of frequencies between ten and 12 kHz and a maximum sensitivity to sounds in the one to two kHz range.

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 1997a; Richardson et al. 1995e).

Fin whales produce a variety of low frequency (less than 1 kHz) sounds, but the most typically recorded is a 20 Hz pulse lasting about one second, and reaching source levels of 189 ±4 dB re: 1 µPa-m (Charif et al. 2002; Clark et al. 2002; Edds 1988; Richardson et al. 1995e; Sirovic et al. 2007; Watkins 1981; Watkins et al. 1987). These pulses frequently occur in long sequenced patterns, are down swept (e.g., 23 to 18 Hz), and can be repeated over the course of many hours (Watkins et al. 1987). In temperate waters, intense bouts of these patterned sounds are very common from fall through spring, but also occur to a lesser extent during the summer in high latitude feeding areas (Clarke and Charif 1998). The seasonality and stereotype nature of these vocal sequences suggest that they are male reproductive displays (Watkins 1981; Watkins et al. 1987); a notion further supported by recent data linking these vocalizations to male fin whales only (Croll et al. 2002). In Southern California, the 20 Hz pulses are the dominant fin whale call type associated both with call-counter-call between multiple animals and with singing (Navy 2010; Navy 2012b). An additional fin whale sound, the 40 Hz call described by Watkins (1981), was also frequently recorded, although these calls are not as common as the 20 Hz fin whale pulses. Seasonality of the 40 Hz calls differed from the 20 Hz calls, since 40 Hz calls were more prominent in the spring, as observed at other sites across the northeast Pacific Ocean (Sirovic et al. 2012). Source levels of Eastern Pacific Ocean fin whale 20 Hz calls has been reported as 189 ± 5.8 dB re: 1 µPa at 1 m (Weirathmueller et al. 2013). Although acoustic recordings of fin whales from many diverse regions show close adherence to the typical 20 Hz bandwidth and sequencing when performing these vocalizations, there have been slight differences in the pulse patterns, indicative of some geographic variation (Thompson et al. 1992; Watkins et al. 1987).

Responses to conspecific sounds have been demonstrated in a number of mysticetes, and there is no reason to believe that fin whales do not communicate similarly (Edds-Walton 1997). The low frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long distance communication occurs in fin whales (Edds-Walton 1997; Payne and Webb. 1971). Also, there is speculation that the sounds may function for long range echolocation of large-scale geographic targets such as seamounts, which might be used for orientation and navigation (Tyack 1999).

Although no studies have directly measured the sound sensitivity of fin whales, experts assume that fin whales are able to receive sound signals in roughly the same frequencies as the signals they produce. This suggests fin whales, like other baleen whales, are more likely to have their best hearing capacities at low frequencies, including frequencies lower than those of normal human hearing, rather than mid- to high-frequencies (Ketten 1997a). Several fin whales were tagged during the Southern California Behavioral Response Study (SOCAL BRS) 2010 and no obvious responses to a mid-frequency sound source were detected by the visual observers or in the initial tag analysis (Southall et al. 2011a). Results of studies on blue whales (Goldbogen et al.

2013; Southall et al. 2011a), which have similar auditory physiology compared to fin whales, indicate that some individuals hear some sounds in the mid-frequency range and exhibit behavioral responses to sounds in this range depending on received level and context, In terms of functional hearing capability fin whales belong to the low-frequency group, which have a hearing range of 7 Hz to 22 kHz (Southall et al. 2007).

Status

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

Critical Habitat

No critical habitat has been designated for the fin whale.

Recovery Goals

See the 2010 Final Recovery Plan for the fin whale for complete downlisting/delisting criteria for both of the following recovery goals.

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

5.6 Gray Whale – Western North Pacific Population

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 13).

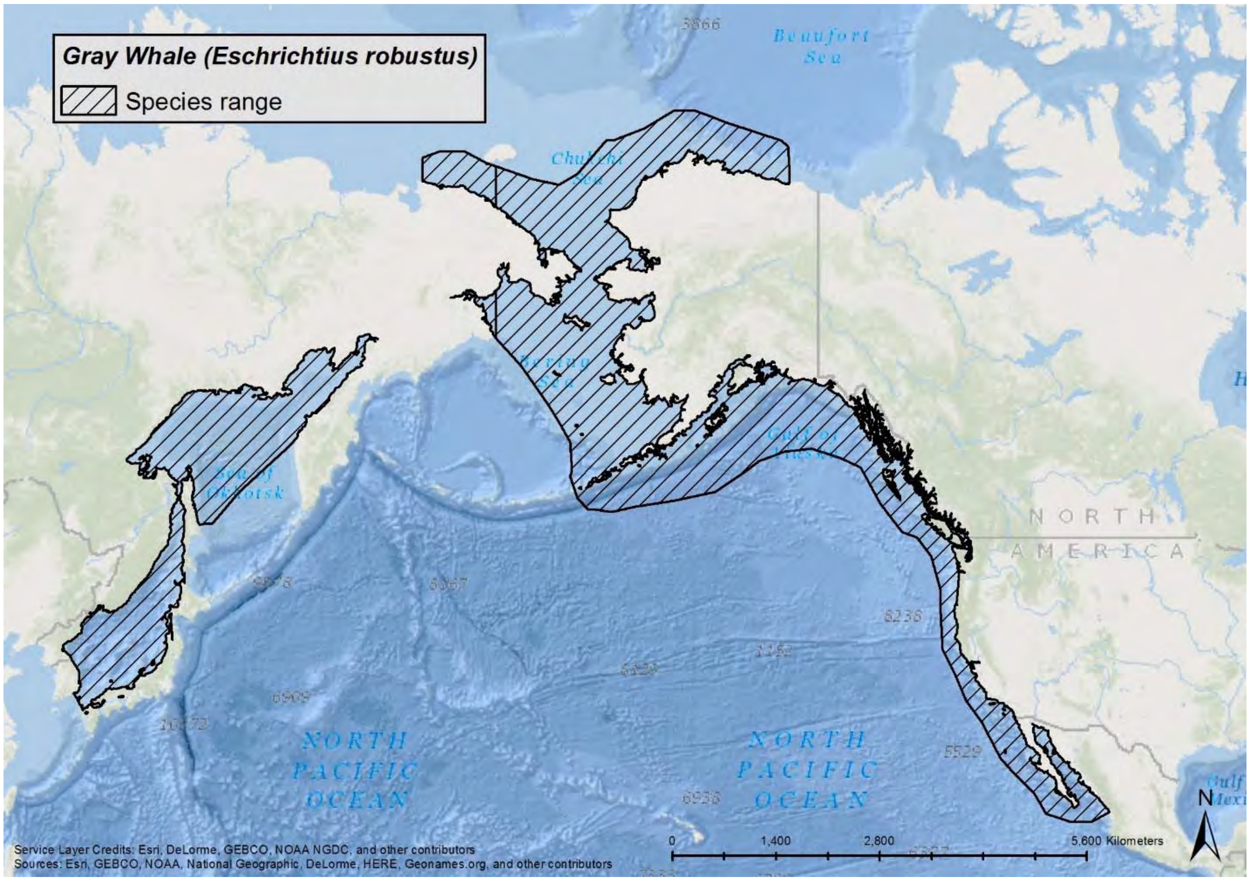

Figure 13. Map identifying the range of the gray whale.

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. The Eastern North Pacific stock was officially delisted on June 16, 1994 when it reached pre-exploitation numbers. The Western North Pacific population of gray whales remained listed as endangered (Table 46).

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

Life History

The average life span of gray whales is unknown but it is thought to be as long as 80 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 12 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.

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.

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. 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 Ocean, which may indicate that not all gray whales share the same migratory patterns.

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 μPa 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 µPa 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. 1986; Moore and Clark 2002).

Status

The Western North Pacific population of 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.

Critical Habitat

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

Recovery Goals

There is currently no Recovery Plan for the Western North Pacific population of gray whale. In general, ESA-listed species, which occur entirely outside U.S. jurisdiction, are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

5.7 Humpback Whale – Arabian Sea Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 14).

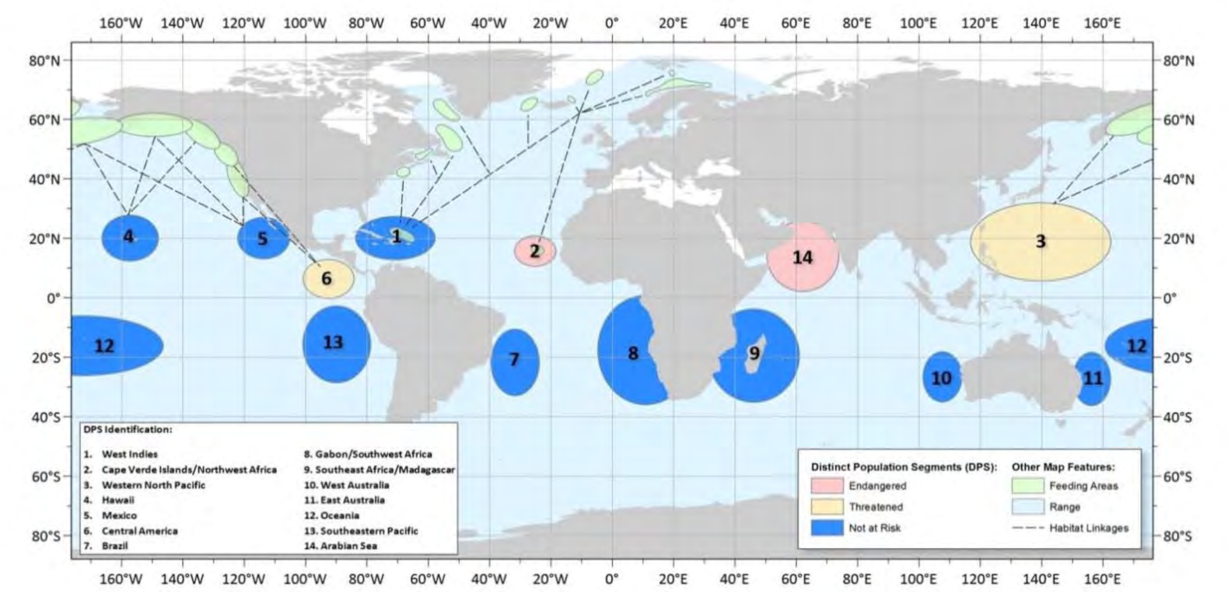

Figure 14. Map identifying 14 distinct population segments with one threatened and four endangered, based on primarily breeding location of the humpback whale, their range, and feeding areas (Bettridge et al. 2015).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 46).

Information available from the recovery plan (NMFS 1991a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), the status review (Bettridge et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 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 lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales 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).

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 Arabian Sea DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Arabian Sea DPS is 82. A population growth rate is currently unavailable for the Arabian Sea DPS humpback whale.

For humpback whales, DPSs 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 of five hundred individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population 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 entire range of the Arabian Sea DPS has not been surveyed, but the most recent estimate abundance is less than 100 individuals, putting it at high risk of extinction due to lack of genetic diversity. The low abundance of this DPS suggests that the population has reached a genetic bottleneck and is at an increased risk to impacts from inbreeding, such as reduced genetic fitness and susceptibility to disease (Bettridge et al. 2015).

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. 2006a; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995e; Winn et al. 1970). 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 1986; Tyack 1983). Such sounds can be heard up to 9 km (4.9 nmi) away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995e; Tyack 1983). 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 µPa at 1 m) (Au et al. 2000b; Erbe 2002a; Payne 1985; Richardson et al. 1995e; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995e). 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. (2001b) 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 µPa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006a; Winn et al. 1970).

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 1986; 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 µPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with Digital Acoustic Recording Tags[3] (DTAGs) (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

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[3] DTAG is a novel archival tag, developed to monitor the behavior of marine mammals, and their response to sound, continuously throughout the dive cycle. The tag contains a large array of solid-state memory and records continuously from a built-in hydrophone and suite of sensors. The sensors sample the orientation of the animal in three dimensions with sufficient speed and resolution to capture individual fluke strokes. Audio and sensor recording is synchronous so the relative timing of sounds and motion can be determined precisely Johnson, M. P., and P. L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. IEEE Journal of Oceanic Engineering 28(1):3-12.

"mega-clicks" which showed relatively low received levels at the DTAGs (143 to 154 dB re: 1 µPa), 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. 2007). 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. (2006b) 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 (1990) 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 µPa-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.

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 America, 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 whaling 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 Arabian Sea DPS still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/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.

5.8 Humpback Whale – Cape Verde Islands/Northwest Africa Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 14).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 46).

Information available from the recovery plan (NMFS 1991a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), the status review (Bettridge et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 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 lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales 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).

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 Cape Verde Islands/Northwest Africa DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Cape Verde Islands/Northwest Africa DPS is unknown (81 FR 62259). A population growth rate is currently unavailable for the Cape Verde Islands/Northwest Africa DPS of humpback whales.

For humpback whales, DPSs 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 of five hundred individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population 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 population size of the Cape Verde Islands/Northwest Africa is unknown at this time and therefore evidence of genetic diversity (or lack of) cannot be determined (Bettridge et al. 2015).

The Cape Verde Islands/Northwest Africa DPS consists of humpback whales whose breeding range includes waters surrounding the Cape Verde Islands as well as undetermined breeding area in the eastern tropical Atlantic, and possibly the Caribbean. Its feeding range includes primarily Iceland and Norway (Figure 14).

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. 2006a; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995e; Winn et al. 1970). 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 1986; Tyack 1983). Such sounds can be heard up to 9 km (4.9 nmi) away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995e; Tyack 1983). 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 µPa at 1 m) (Au et al. 2000b; Erbe 2002a; Payne 1985; Richardson et al. 1995e; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995e). 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. (2001b) 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 µPa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006a; Winn et al. 1970).

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 1986; 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 µPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs[3] (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 µPa), 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. 2007). 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. (2006b) 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 (1990) 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 µPa-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.

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 America, 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 whaling 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 Cape Verde Islands/Northwest Africa DPS still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/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.

5.9 Humpback Whale – Central America Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 14).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 46).

Information available from the recovery plan (NMFS 1991a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), the status review (Bettridge et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 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 lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales 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).

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 America DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Central America DPS is 411. A population growth rate is currently unavailable for the Central America DPS of humpback whales.

For humpback whales, DPSs 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 of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population 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 Central America DPS has just below 500 individuals and so may be subject to genetic risks due to inbreeding and moderate environmental variance (Bettridge et al. 2015).

The Central America DPS is composed of humpback whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras, and Nicaragua. This DPS feeds almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington – southern British Columbia feeding grounds (Figure 14).

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. 2006a; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995e; Winn et al. 1970). 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 1986; Tyack 1983). Such sounds can be heard up to 9 km (4.9 nmi) away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995e; Tyack 1983). 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 μPa at 1 m) (Au et al. 2000b; Erbe

2002a; Payne 1985; Richardson et al. 1995e; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995e). 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. (2001b) 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 µPa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006a; Winn et al. 1970).

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 1986; 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 µPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs[3] (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 μPa), 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. 2007). 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. (2006b) 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 (1990) 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 μPa-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.

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 America, 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 whaling 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 Central America DPS still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/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.

5.10 Humpback Whale – Mexico Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 14).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970 (35 FR 18319). Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 46).

Information available from the recovery plan (NMFS 1991a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), the status review (Bettridge et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 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 lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales 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).

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 Mexico DPS of humpback whales.

The global, pre-exploitation estimate for humpback whales is 1,000,000 (Roman and Palumbi 2003). The current abundance of the Mexico DPS is unavailable.

A population growth rate is currently unavailable for the Mexico DPS of humpback whales.

For humpback whales, DPSs 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 of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population 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 Mexico DPS is estimated to have more than 2,000 individuals and thus, should have enough genetic diversity for long-term persistence and protection from substantial environmental variance and catastrophes (Bettridge et al. 2015).

The Mexico DPS is composed of humpback whales that breed along the Pacific coast of mainland Mexico, and the Revillagigedos Islands, and transit through the Baja California Peninsula coast. This DPS feeds across a broad geographic range from California to the Aleutian Islands, with concentrations in California-Oregon, northern Washington-southern British Columbia, northern and western Gulf of Alaska, and Bering Sea feeding grounds (Figure 14) (81 FR 62259).

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. 2006a; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995e; Winn et al. 1970). 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 1986; Tyack 1983). Such sounds can be heard up to 9 km (4.9 nmi) away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995e; Tyack 1983). 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 µPa at 1 m) (Au et al. 2000b; Erbe 2002a; Payne 1985; Richardson et al. 1995e; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995e). 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. (2001b) 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 µPa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006a; Winn et al. 1970).

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 1986; 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 µPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs[3] (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 µPa), 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. 2007). 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. (2006b) 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 (1990) 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 µPa-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.

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 America, 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 whaling 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 Mexico DPS still faces a risk of becoming endangered within the foreseeable future throughout all or a significant portion of its range.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/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.

5.11 Humpback Whale – Western North Pacific Distinct Population Segment

The humpback whale is a widely distributed baleen whale found in all major oceans (Figure 14).

Humpbacks are distinguishable from other whales by long pectoral fins and are typically dark grey with some areas of white. They humpback whale was originally listed as endangered on December 2, 1970. Since then, NMFS has designated 14 DPSs with four identified as endangered (Cape Verde Islands/Northwest Africa, Western North Pacific, Central America, and Arabian Sea) and one as threatened (Mexico) (Table 46).

Information available from the recovery plan (NMFS 1991a), recent stock assessment reports (Carretta et al. 2016; Muto et al. 2016; Waring et al. 2016a), the status review (Bettridge et al. 2015), and the final listing were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Humpback whales can live, on average, 50 years. They have a gestation period of eleven to 12 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 lower latitudes, where they calve and nurse, and summer at high latitudes, where they feed. Humpback whales 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).

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 DPS of humpback whales.

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

For humpback whales, DPSs 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 of 500 individuals or less may be at a greater risk of extinction due to genetic risks resulting from inbreeding. Population 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 sub-populations, 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 (Bettridge et al. 2015).

The Western North Pacific DPS is composed of humpback whales that breed/winter 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 14).

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. 2006a; Au et al. 2000b; Frazer and Mercado III 2000; Richardson et al. 1995e; Winn et al. 1970). 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 1986; Tyack 1983). Such sounds can be heard up to 9 km (4.9 nmi) away (Tyack 1983). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Richardson et al. 1995e;

Tyack 1983). 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 µPa at 1 m) (Au et al. 2000b; Erbe 2002a; Payne 1985; Richardson et al. 1995e; Thompson et al. 1986). However, humpback whales tend to be less vocal in northern feeding areas than in southern breeding areas (Richardson et al. 1995e). 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. (2001b) 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 µPa-m and high frequency harmonics extending beyond 24 kHz (Au et al. 2006a; Winn et al. 1970).

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 1986; 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 µPa-m (D'Vincent et al. 1985; Thompson et al. 1986). The fundamental frequency of feeding calls is approximately 500 Hz (D'Vincent et al. 1985; Thompson et al. 1986). The acoustics and dive profiles associated with humpback whale feeding behavior in the northwest Atlantic Ocean has been documented with DTAGs[3] (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 µPa), 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. 2007). 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. (2006b) 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 (1990) 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 µPa-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.

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 America, 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 whaling 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 of humpback whales still faces a risk of extinction.

Critical Habitat

No critical habitat has been designated for humpback whales.

Recovery Goals

See the 1991 Final Recovery Plan for the humpback whale for the complete downlisting/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.

5.12 Killer Whale – Southern Resident Distinct Population Segment

Killer whales are distributed worldwide, but populations are isolated by region and ecotype. Killer whales have been divided into distinct population segments on the basis of differences in genetics, ecology, morphology and behavior. The Southern Resident DPS of killer whale can be found along the Pacific Coast of the United States and Canada, and in the Salish Sea, Strait of Juan de Fuca, and Puget Sound (Figure 15).

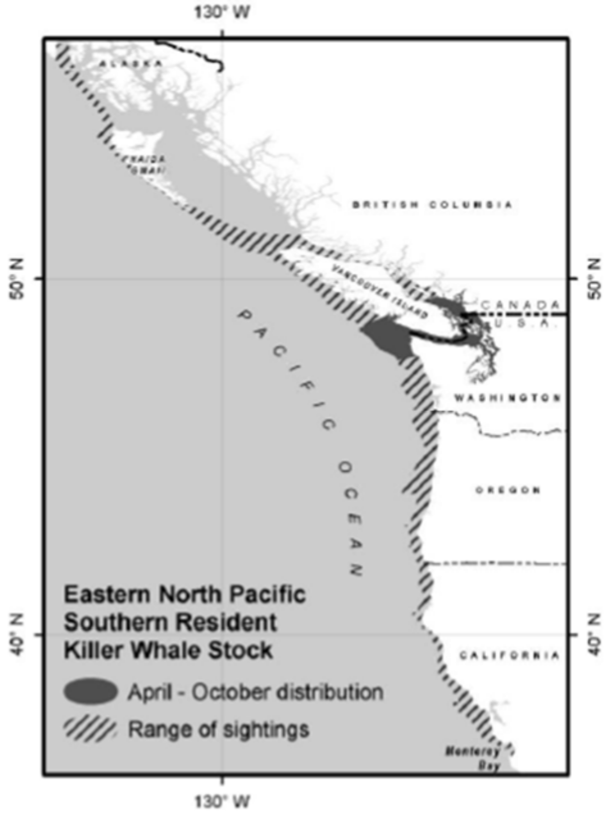

Figure 15. Map identifying the range of the endangered Southern Resident distinct population segment of killer whale. Approximate April to October distribution of the Southern Resident distinct population segment of killer whale (shaded area) and range of sightings (diagonal lines) (Carretta et al. 2016) .

Killer whales are odontocetes and the largest delphinid species with black coloration on their dorsal side and white undersides and patches near the eyes. They also have a highly variable gray or white saddle behind the dorsal fin. The Southern Resident DPS of killer whales was listed as endangered under the ESA on November 18, 2005 (Table 46).

We used information available in the final rule, the Recovery Plan (NMFS 2008b), the 2016 Status Review (NMFS 2016) and the recent stock Assessment report (Carretta et al. 2017) to summarize the life history, population dynamics and status of this species, as follows.

Life History

Southern Resident DPS of killer whales are geographically, matrilineally, and behaviorally distinct from other killer whale populations. The Southern Resident DPS includes three large, stable pods (J, K, and L), which occasionally interact (Parsons et al. 2009). Most mating occurs outside natal pods, during temporary associations of pods, or as a result of the temporary dispersal of males (Pilot et al. 2010). Males become sexually mature at ten to 17 years of age. Females reach maturity at 12 to 16 years of age and produce an average of 5.4 surviving calves during a reproductive life span of approximately 25 years. Mothers and offspring maintain highly stable, life-long social bonds, and this natal relationship is the basis for a matrilineal social structure. They prey upon salmonids, especially Chinook salmon (Hanson et al. 2010).

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 Southern Resident killer whale.

The most recent abundance estimate for the Southern Resident DPS is 81 whales in 2015 (Carretta et al. 2017) (80 whales in 2016[4]). This represents a decline from just a few years ago, when in 2012, there were 85 whales. Population abundance has fluctuated over time with a maximum of approximately 100 whales in 1995 (Carretta et al. 2017), with an increase between 1974 and 1993, from 76 to 93 individuals. As compared to stable or growing populations, the DPS reflects lower fecundity and has demonstrated little to no growth in recent decades (NMFS 2016).

For the period between 1974 and the mid-1990s, when the population increased from 76 to 93 animals, the population growth rate was 1.8 percent (Ford et al. 1994). More recent data indicate the population is now in decline (Carretta et al. 2017).

After thorough genetic study, the Biological Review Team concluded that Southern Resident DPS of killer whales were discrete from other killer whale groups (NMFS 2008). Despite the fact that their ranges overlap, Southern Resident DPS of killer whales do not intermix with Northern Resident killer whales. Southern Resident DPS of killer whales consist of three pods, called J, K, and L. Low genetic diversity within a population is believed to be in part due to the matrilineal social structure (NMFS 2008).

Southern Resident DPS of killer whales occur in the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait during the spring, summer and fall. During the

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[4] http://www.orcanetwork.org/Main/index.php?categories_file=Births%20and%20Deaths; accessed 11/15/2016

winter, they move to coastal waters primarily off Oregon, Washington, California, and British Columbia (Figure 15).

Vocalization and Hearing

Killer whales have advanced vocal communication and also use vocalizations to aid in navigation and foraging (NMFS 2008b). Their vocalizations typically have both a low frequency component (250 Hz to 1.5 kHz) and a high frequency component (five to 12 kHz) (NMFS 2008b). Killer whale vocalizations consist of three main types, echolocation clicks, which are primarily used for navigation and foraging, and tonal whistles and pulse calls, which are thought to be used for communication (NMFS 2008b). Individual Southern Resident DPS pods have distinct call repertoires, with each pod being recognizable by its acoustic dialect (NMFS 2008b). Killer whale hearing is one of the most sensitive of any odontocete, with a hearing range of one to 120 kHz, with the most sensitive range being between 18 and 42 kHz range (Szymanski et al. 1999).

Status

The Southern Resident DPS of killer whale was listed as endangered in 2005 in response to the population decline from 1996 to 2001, small population size, and reproductive limitations (i.e., few reproductive males and delayed calving). Current threats to its survival and recovery include contaminants, vessel traffic, and reduction in prey availability. Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants. These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment. The inland waters of Washington and British Columbia support a large whale watch industry, commercial shipping, and recreational boating; these activities generate underwater noise, which may mask whales' communication or interrupt foraging. The factors that originally endangered the species persist throughout its habitat: contaminants, vessel traffic, and reduced prey. The DPS's resilience to future perturbation is reduced as a result of its small population size. The recent decline, unstable population status, and population structure (e.g., few reproductive age males and non-calving adult females) continue to be causes for concern. The relatively low number of individuals in this population makes it difficult to resist or recover from natural spikes in mortality, including disease and fluctuations in prey availability.

Critical Habitat

On November 29, 2006, NMFS designated critical habitat for the Southern Resident DPS of killer whale (71 FR 69054). The critical habitat consists of approximately 6,630 km^2 (1,933 nmi^2) in three areas: the Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca (Figure 16). It provides the following physical and biological features essential to the conservation of Southern Resident DPS of killer whales: water quality to support growth and development; prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and inter-area passage conditions to allow for migration, resting, and foraging.

Figure 16. Map depicting designated critical habitat for the endangered Southern Resident distinct population segment of killer whale.

Recovery Goals

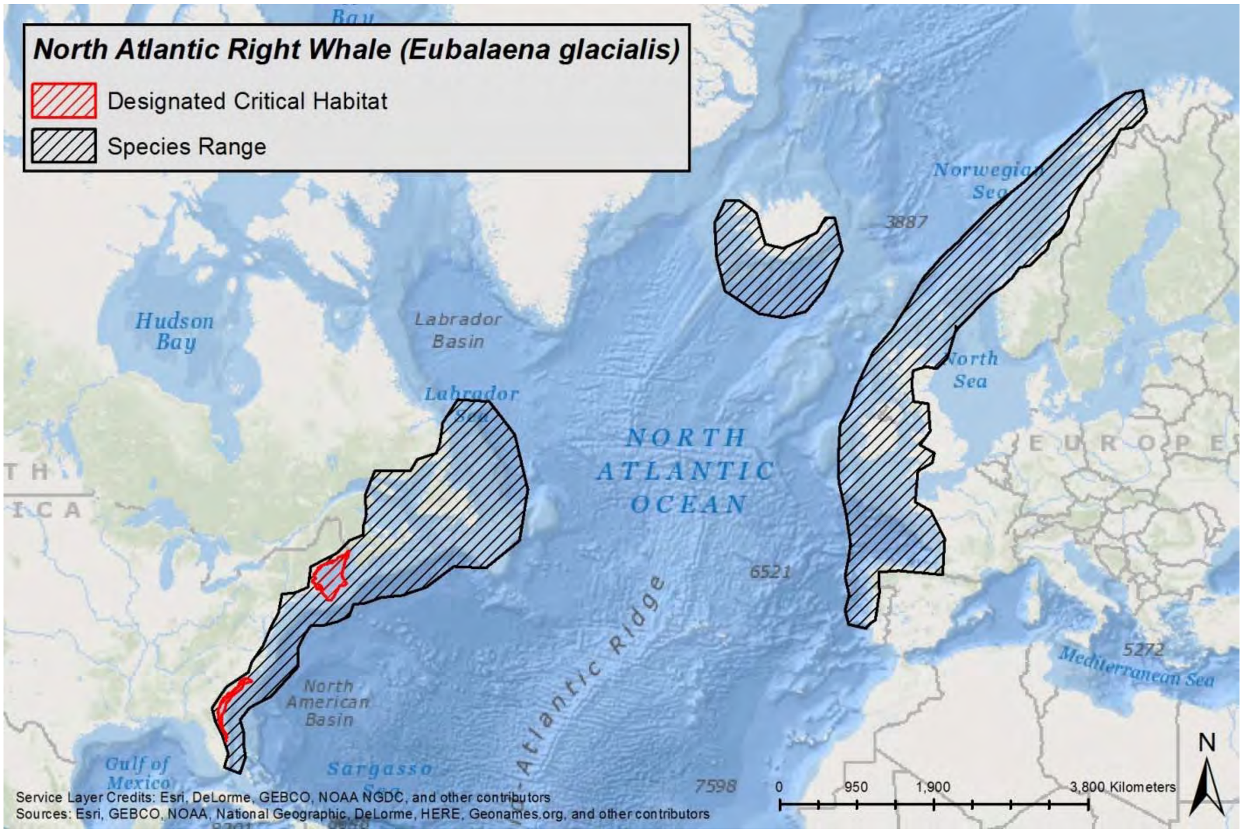
See the 2008 Final Recovery Plan for the Southern Resident DPS of killer whale for complete downlisting/delisting criteria for each of the following recovery goals.

1. Prey Availability: Support salmon restoration efforts in the region including habitat, harvest and hatchery management considerations and continued use of existing NMFS authorities under the ESA and Magnuson-Stevens Fishery Conservation and Management Act to ensure an adequate prey base

2. Pollution/Contamination: Clean up existing contaminated sites, minimize continuing inputs of contaminants harmful to killer whales, and monitor emerging contaminants.
3. Vessel Effects: Continue with evaluation and improvement of guidelines for vessel activity near Southern Resident DPS of killer whales and evaluate the need for regulations or protected areas.
4. Oil Spills: Prevent oil spills and improve response preparation to minimize effects on Southern Resident DPS and their habitat in the event of a spill.
5. Acoustic Effects: Continue agency coordination and use of existing ESA and MMPA mechanisms to minimize potential impacts from anthropogenic sound.
6. Education and Outreach: Enhance public awareness, educate the public on actions they can participate in to conserve killer whales and improve reporting of Southern Resident DPS killer whale sightings and strandings.
7. Response to Sick, Stranded, Injured Killer Whales: Improve responses to live and dead killer whales to implement rescues, conduct health assessments, and determine causes of death to learn more about threats and guide overall conservation efforts.
8. Transboundary and Interagency Coordination: Coordinate monitoring, research, enforcement, and complementary recovery planning with Canadian agencies, and Federal and State partners.
9. Research and Monitoring: Conduct research to facilitate and enhance conservation efforts. Continue the annual census to monitor trends in the population, identify individual animals, and track demographic parameters.

5.13 North Atlantic Right Whale

The North Atlantic right whale is a narrowly distributed baleen whale found in temperate and sub-polar latitudes in the North Atlantic Ocean (Figure 17).



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 17. Map identifying range and critical habitat of the endangered North Atlantic right whale.

The North Atlantic right whale is a narrowly distributed baleen whale, distinguished by its stocky body and lack of a dorsal fin. The species was originally listed as endangered on December 2, 1970 (Table 46). The North Atlantic right whale was listed separately as endangered on March 6, 2008 (Table 46).

We used information available in the five-year review (Colligan et al. 2012)**,** the most recent stock assessment report (Hayes et al. 2017), and the scientific literature to summarize the life history, population dynamics, and status of the species as follows.

Life History

The lifespan of North Atlantic right whales is unknown, but some individuals appear to live to be at least fifty years old (Kenney 2009). Their gestation is 12 to 13 months, and calves are nursed for eight to 17 months. The average calving interval is three to five years and they reach sexual maturity at nine years of age. They migrate to low latitudes during the winter to give birth in shallow, coastal waters, and in summer, feed on large concentrations of copepods in the high latitudes (Colligan et al. 2012)

Population Dynamics

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

There are currently two recognized populations of North Atlantic right whales, a western and an eastern population. There are at least 440 individuals in the western North Atlantic population (Hayes et al. 2017). This estimate is based on a review of the photo-identification recapture database as it existed in October 2013 and represents a minimum population size. Less than 20 individuals exist in the eastern North Atlantic Ocean, and as such, this population may be functionally extinct (Colligan et al. 2012). Pre-exploitation abundance is not available for the species. The western population may have numbered fewer than 100 individuals by 1935 when international protection for right whales came into effect (Kenney et al. 1995). Little is known about the population dynamics of North Atlantic right whales in the intervening years.

In the western North Atlantic Ocean, the species demonstrated overall growth rates of 2.6 percent over the period 1990 to 2010, despite two periods of increased mortality during that time span (Hayes et al. 2017). However, in most recent years, photo-identification data indicate the populations is now in decline (Hayes et al. 2017; Kraus et al. 2016).

Analysis of mitochondrial DNA from North Atlantic right whales has identified seven mitochondrial DNA haplotypes in the western North Atlantic Ocean. This is significantly less diverse than Southern right whales and may indicate inbreeding. While analysis of historic DNA taken from museum specimens indicates that the eastern and western populations were likely not genetically distinct, the lack of recovery of the eastern North Atlantic population indicates at least some level of population segregation. Overall, the species has low genetic diversity as would be expected based on its low abundance (Hayes et al. 2017)

Today, North Atlantic right whales are primarily found in the western North Atlantic Ocean, from their breeding grounds in lower latitudes off the coast of the southeastern U.S. to their feeding grounds in higher latitudes off the coast of Nova Scotia (Hayes et al. 2017). Very few, if any, individuals are thought to make up the population in the eastern Atlantic Ocean (Hayes et al. 2017). However, in recent years a few known individuals from the western population have been seen in the eastern Atlantic Ocean, suggesting some individuals may have wider ranges than previously thought (Kenney 2009).

Vocalization and Hearing

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 2002b; 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. 2005b).

Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001b). Moans are usually produced within 10 m (33 ft) of the surface (Matthews et al. 2001b). 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 µPa peak-to-peak (Hotchkin 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 top 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 µPa-m (rms), except for gunshots, which are 174 to 192 dB re: 1 µPa-m (rms) (Parks and Tyack 2005). Up calls may also be used to reunite mothers with calves (Parks and Clark 2007). North 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. 2005a; Parks et al. 2007b; 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. 2004c).

There is no direct data on the hearing range of North Atlantic 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. 2007c).

Status

The North Atlantic right whale is listed as endangered under the ESA. With whaling now prohibited, the two major threats to the survival and recovery of the species are ship strikes and entanglement in fishing gear. Substantial progress has been made in mitigating ship strikes by regulating vessel speeds (78 FR 73726) (Conn and Silber 2013; Waring et al. 2016a), but entanglement in fishing gear remains a major threat (Kraus et al. 2016). In addition, while population trends have been positive since its original listing, the species may now be in decline and its resilience to future perturbations is low due to its small population size.

Critical Habitat

Critical habitat for North Atlantic right whales was designated in 1994 and expanded in 2016. It includes two major units: Unit 1 located in the Gulf of Maine and Georges Bank Region and

Unit 2 located off the coast of North Carolina, South Carolina, Georgia, and Florida (Figure 17). Unit 1 consists of important foraging area and contains the following physical and biological features essential to the conservation of the species: the physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank region that combine to distribute and aggregate the zooplankton species *Calanus finmarchicus* for North Atlantic right whale foraging, namely prevailing currents and circulation patterns, bathymetric features (basins, banks, and channels), oceanic fronts, density gradients, and temperature regimes, low flow velocities in Jordan, Wilkinson, and Georges Basins that allow diapausing *C. finmarchicus* to aggregate passively below the convective layer so that the copepods are retained in the basins; late stage *C. finmarchicus* in dense aggregations in the Gulf of Maine and Georges Bank region; and diapuasing *C. finmarchicus* in aggregations in the Gulf of Maine and Georges Bank region. Unit 2 consists of an important calving area and contains the following physical and biological features essential to the conservation of the species: sea surface conditions associated with Force 4 or less on the Beaufort Scale, sea surface temperatures 7 to 17° C, and water depths of 6 to 28 m (19.7 to 91.9 ft), where these features simultaneously co-occur over contiguous areas of at least 792.3 km^2 (231 nmi^2) of ocean waters during the months of November through April.

Recovery Goals

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

1. The population ecology (range, distribution, age structure, and gender ratios, etc.) and vital rates (age-specific survival, age-specific reproduction, and lifetime reproductive success) of North Atlantic right whales are indicative of an increasing population;
2. The population has increased for a period of 35 years at an average rate of increase equal to or greater than two percent per year;
3. None of the known threats to North Atlantic right whales are known to limit the population’s growth rate; and
4. Given current and projected threats and environmental conditions, the North Atlantic right whale population has no more than a one percent chance of quasi-extinction in one hundred years.

5.14 North Pacific Right Whale

North Pacific right whales are found in temperate and sub-polar waters of the North Pacific Ocean (Figure 18).

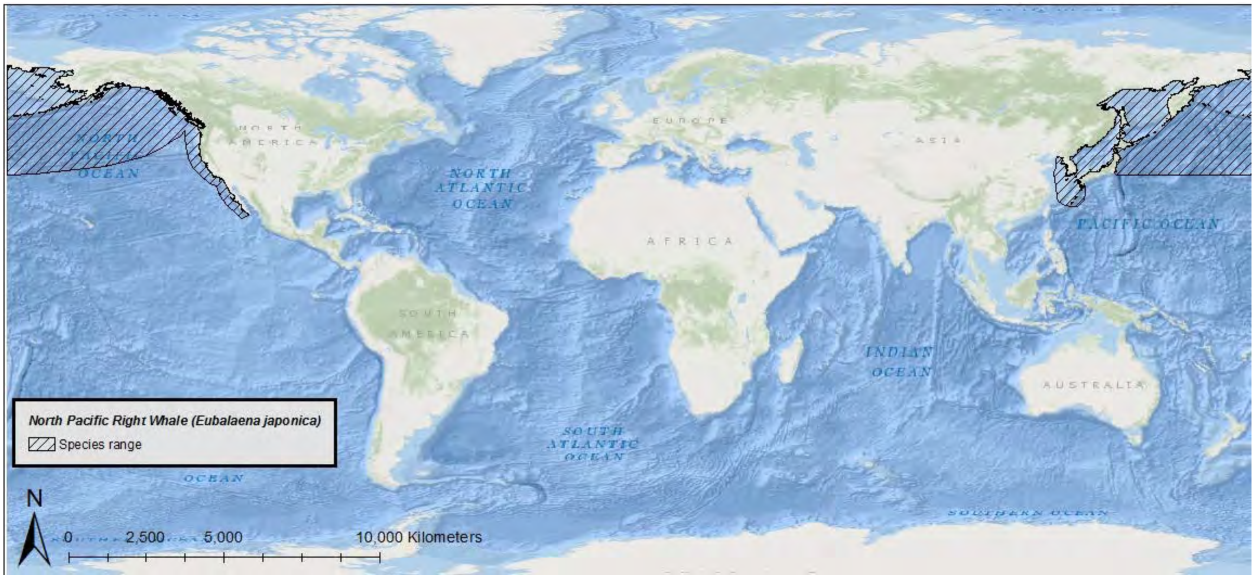


Figure 18. Map identifying the range of the endangered North Pacific right whale.

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. The North Pacific right whale was listed separately as endangered on March 6, 2008 (Table 46).

Information available from the recovery plan (NMFS 2013a) recent stock assessment reports (Muto et al. 2017), and status review (NMFS 2012a) were used to summarize the life history, population dynamics and status of the species as follows.

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 nine and ten 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.

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. There are two currently recognized stocks of North Pacific right whales, a Western North Pacific stock that feeds primarily in the Sea of Okhotsk, and an Eastern North Pacific stock that feeds in eastern north Pacific Ocean waters off Alaska, Canada, and Russia. Several lines of evidence indicate a total population size of less than 100 for the Eastern North Pacific stock. Based on photo-identification from 1998 to 2013 (Wade et al. 2011) estimated 31 individuals, with a minimum population estimate of 26 individuals (Muto et al. 2017). Genetic data have identified 23 individuals based on samples collected between 1997 and 2011 (Leduc et al. 2012). The Western North Pacific stock is likely more abundant and was estimated to consist of 922 whales (95 percent confidence intervals 404 to 2,108) based on data collected in 1989, 1990, and 1992 (IWC 2001; Thomas et al. 2016). While there have been several sightings of Western North Pacific right whales in recent years, with one sighting identifying at least 77 individuals, these data have yet to be compiled to provide a more recent abundance estimate (Thomas et al. 2016). 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, 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° North latitude (Figure 18). Prior to exploitation by commercial whalers, concentrations of North Pacific right whales where 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 North Pacific 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. In the Western North Pacific Ocean where the population is thought to be somewhat larger, North Pacific right whales have been sighted in the Sea of Okhotsk and other areas off the coast of Japan, Russia, and South Korea (Thomas et al. 2016). Although North Pacific right whales are typical found in higher latitudes, they are thought to migrate to more temperate waters during winter to reproduce, and have been sighted as far south as Hawaii and Baja California.

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 2002b; 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. 2005b).

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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. 2007c).

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.

Critical Habitat

In 2008, NMFS designated critical habitat for the North Pacific right whale, which includes an area in the Southeast Bering Sea and an area south of Kodiak Island in the Gulf of Alaska (Figure 19). These areas are influenced by large eddies, submarine canyons, or frontal zones which enhance nutrient exchange and act to concentrate prey. These areas are adjacent to major ocean currents and are characterized by relatively low circulation and water movement. Both critical habitat areas support feeding by North Pacific right whales because they contain the designated physical and biological features (previously referred to as primary constituent elements), which include: nutrients, physical oceanographic processes, certain species of zooplankton, and a long photoperiod due to the high latitude. Consistent North Pacific right whale sightings are a proxy for locating these elements.

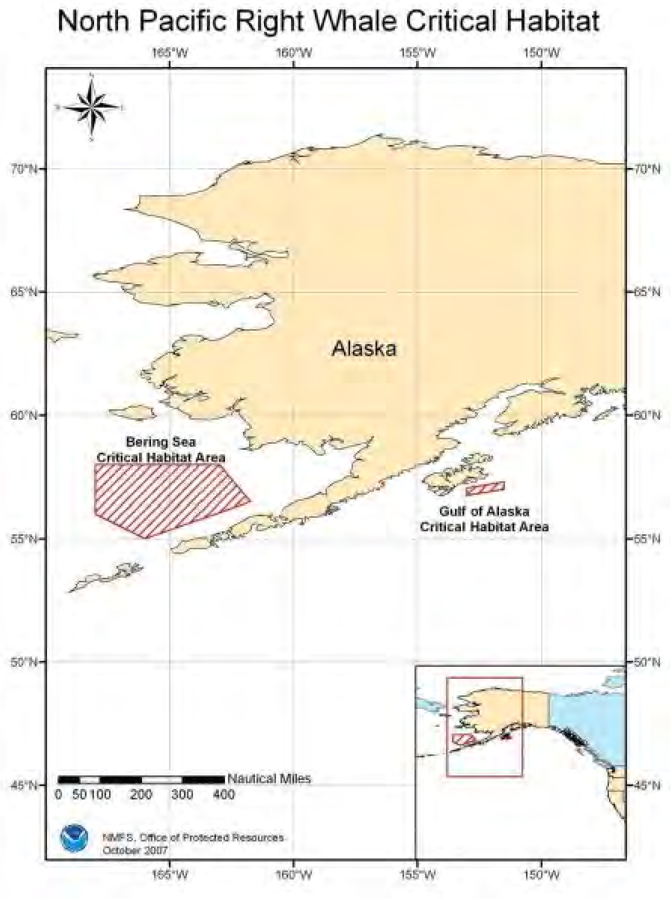


Figure 19. Map identifying designated critical habitat for the North Pacific right whale in the Southeast Bering Sea and south of Kodiak Island in the Gulf of Alaska.

Recovery Goals

See the 2013 Final Recovery Plan for the North Pacific right whale for complete downlisting/delisting criteria for both of the following recovery goals.

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

5.15 Sei Whale

The sei whale is a widely distributed baleen whale found in all major oceans (Figure 20).

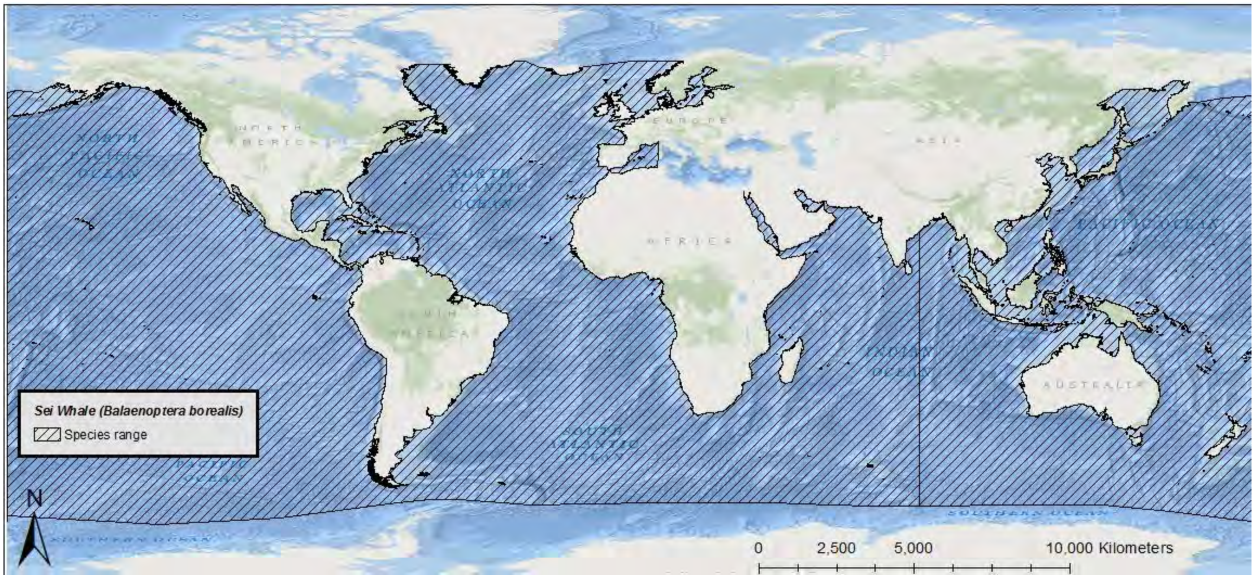


Figure 20. Map identifying the range of the endangered sei whale.

Sei whales are distinguishable from other whales by a long, sleek body that is dark bluish-gray to black in color and pale underneath, and a single ridge located on their rostrum. The sei whale was originally listed as endangered on December 2, 1970 (Table 46).

Information available from the recovery plan (NMFS 2011d), recent stock assessment reports (Carretta et al. 2017; Hayes et al. 2017; Muto et al. 2017), and status review (NMFS 2012d) were used to summarize the life history, population dynamics and status of the species as follows.

Life History

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

Population Dynamics

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

Two sub-species of sei whale are recognized, *B. b. borealis* in the Northern Hemisphere and *B. b. schlegellii* in the Southern Hemisphere. There are no estimates of pre-exploitation abundance for the North Atlantic Ocean. Models indicate that total abundance declined from 42,000 to 8,600 individuals between 1963 and 1974 in the North Pacific Ocean. More recently, the North Pacific Ocean population was estimated to be 29,632 (95 percent confidence intervals 18,576 to 47,267) between 2010 and 2012 (IWC 2016; Thomas et al. 2016). In the Southern Hemisphere, pre-exploitation abundance is estimated at 65,000 whales, with recent abundance estimated at 9,800 to 12,000 whales. Three relatively small stocks occur in U.S. waters: Nova Scotia (N=357, N_{min}=236), Hawaii (N=178, N_{min}=93), and Eastern North Pacific (N=519, N_{min}=374). Population growth rates for sei whales are not available at this time as there are little to no systematic survey efforts to study sei whales.

While some genetic data exist sei whales, current samples sizes are small limiting our confidence in their estimates of genetic diversity (NMFS 2011d). 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 than100) 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. All stocks of sei whales within U.S. waters are estimated to be below 500 individuals indicating they may be at risk of extinction due to inbreeding.

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

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 second duration and tonal and upsweep calls in the 200 to 600 Hz range of one to three second durations (McDonald et al. 2005). Vocalizations from the North Atlantic consisted of paired sequences (0.5 to 0.8 seconds, separated by 0.4 to 1.0 seconds) of 10 to 20 short (4 milliseconds) frequency modulated sweeps between 1.5 to 3.5 kHz (Thomson and Richardson 1995b). Source levels of 189 ±5.8 dB re: 1µPa at 1 m have been established for sei whales in the northeastern Pacific Ocean (Weirathmueller et al. 2013). It is presumed sei whales hear in the same frequencies bands in which they vocalize, and are likely most sensitive to sounds in this frequency range.

Status

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

Critical Habitat

No critical habitat has been designated for the sei whale.

Recovery Goals

See the 2011 Final Recovery Plan for the sei whale for complete downlisting/delisting criteria for both of the following recovery goals.

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

5.16 South Island Hector’s Dolphin

The South Island Hector’s dolphin is a small delphinid species found only in coastal waters off New Zealand. It is one of two recognized sub-species of Hector’s dolphin (the other being Maui’s dolphins), based on genetic and morphological data, and occurs off the South Island of New Zealand (Figure 21). As noted previously, the Maui’s dolphin is not likely to be adversely affected by the proposed action so only the South Island Hector’s dolphin is discussed below in further detail.

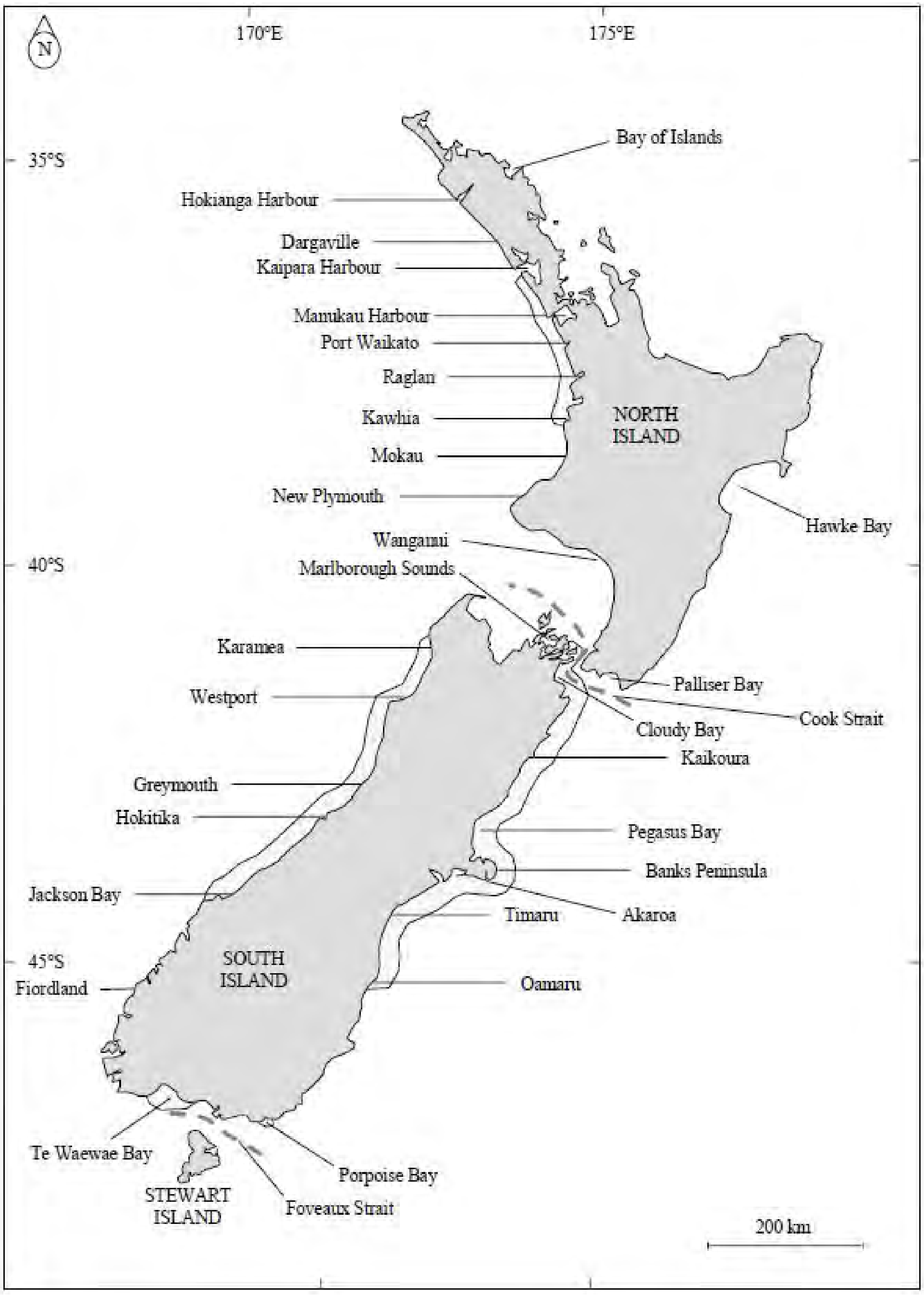


Figure 21. Map identifying the ranges (shaded coastlines) of the South Island Hector's dolphin (South Island) off the coast of New Zealand (Pichler 2002).

South Island Hector's dolphins are small (up to 1.2 m [4 ft]), have a short and stocky body, no external beak, a rounded dorsal fin and rounded pectoral fins, and relatively large flukes (Manning and Grantz. 2016). They have a distinctive and complex black and white coloration pattern. They were proposed for listing under the ESA as threatened on September 19, 2016 (Table 46).

Information available from the draft status review (Manning and Grantz. 2016), listing documents, and the peer-reviewed literature were used to summarize the life history, population dynamics and status of the species as follows.

Life History

Female South Island Hector’s dolphins reach sexual maturity between seven and nine years of age, males mature slightly earlier between six and nine years, and both sexes can live into their twenties (Slooten 1991). Breeding typically occurs in the austral fall and winter, with most females giving birth to a single calf every two to four years during the austral spring and summer (Slooten and Dawson 1994). Calves remain with their mother until weaning between one and two years of age (Slooten and Dawson 1994). Evidence indicates some South Island Hector’s dolphins appear to migrate from inshore waters during the summer, to offshore waters during the winter, which may be related to shifts in prey distribution or reproductive behavior. South Island Hector’s dolphins feed on a wide variety of prey species including cephalopods, crustaceans, and small fishes, but focus on mid-water and demersal prey species (Miller et al. 2012a).

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 South Island Hector’s dolphins.

The earliest reliable population abundance for South Island Hector’s dolphins is from 1984/1985, with an estimated 3,274 South Island Hector’s dolphins (Dawson and Slooten 1988). Between 1997 and 2001, more advanced methods produced a much larger estimate of 7,270 individuals (95 percent confidence intervals between 5,303 and 9,966) (Slooten et al. 2004), and a more recent study produced an even larger estimate of 14,849 individuals (95 percent confidence intervals between 11,923 and 18,492) (MacKenzie and Clement 2016). The first population trend estimate for South Island Hector’s dolphins comes from data collected from 1984 to 1988 around Banks Peninsula, which resulted in an estimated five percent decline per year (Slooten et al. 1992). Following the establishment of a Marine Mammal Sanctuary around Banks Peninsula in 1988, the population of South Island Hector’s dolphins in this area appeared to improve with a six percent increase in population growth rate (Gormley et al. 2012). Despite this, the population in this area still appears to be in decline at a rate of 0.5 percent per year (Gormley et al. 2012). Range-wide, both a stochastic Schaefer (1954) and Bayesian model suggest substantial declines in South Island Hector’s dolphins since the 1970s and predict continued declines over the next 50 years (Slooten and Davies 2011).

South Island Hector’s dolphins exhibit low genetic diversity compared to more abundant odontocetes (Manning and Grantz. 2016). The exhibit regional population structure with an east coast, west coast, and south coast population all being genetically differentiated. Across populations, South Island Hector’s dolphins exhibit at least 20 different mitochondrial DNA haplotypes, with each regional population having different predominant haplotypes and exhibiting significant genetic differentiation based on 13-locus microsatellite genotypes (Hamner et al. 2012). There is even some evidence of genetic differentiation within these regional populations (Hamner et al. 2016).

South Island Hector's dolphins are only found in coastal waters off the South Island of New Zealand, inhabiting nearshore environments, typically within five nautical miles of shore, although individuals may be found in waters out to 37 km (20 nmi) offshore. Historically, South Island Hector's dolphins are thought to have ranged along entire coastline of the South Island of New Zealand. Today, they are found along the east, west, and south coasts of the South Island. Seasonal distribution changes have been documented in some areas. While across seasons South Island Hector's dolphins are most abundant close to shore, during winter some dolphins migrate further offshore resulting in a more even distribution of dolphins with respect to distance from shore. This change in distribution may be a response to changes in prey density, or the consequence of females seeking warmer shallower waters to give birth in the summer.

Vocalization and Hearing

South Island Hector's dolphins produce high frequency clicks ranging between 112 and 130 kHz with maximum source levels of 163 dB re: 1 μPa (Dawson 1988; Dawson and Thorpe 1990). Unlike most delphinids, they do not appear to produce whistles although they do occasionally produce rapid click pulses that generate an audible "cry" or "squeal" sound (Dawson 1988). Based on the characteristics of their vocalizations, it is thought that South Island Hector's dolphins use sound primarily for foraging, communication, and fine scale navigation but not large-scale navigation (Dawson 1988). We are aware of no information on the hearing range of South Island Hector's dolphins, but assume they hear best in the frequency range at which they produce sound (112 and 130 kHz).

Status

The South Island Hector's dolphin shows evidence of a population decline, which is thought to be primarily due to bycatch in commercial and recreational gillnets and trawls (Manning and Grantz. 2016). While changes in the management of New Zealand fisheries appear to have reduced some of the impacts from this threat, the sub-species is expected to continue to decline as a result of bycatch (Manning and Grantz. 2016). Habitat modification and degradation due to development and industrial activities, and disease and tourism also pose a threat to the subspecies (Manning and Grantz. 2016). The South Island Hector's dolphin is at moderate risk of extinction and is proposed for listing as threatened under the ESA (Manning and Grantz. 2016).

Critical Habitat

No critical habitat has been designated for the South Island Hector's dolphin. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a recovery plan for the South Island Hector's dolphin. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

5.17 Southern Right Whale

Southern right whales are a large baleen whale species distributed in the Southern Hemisphere worldwide from 20 to 60° South (Figure 15).

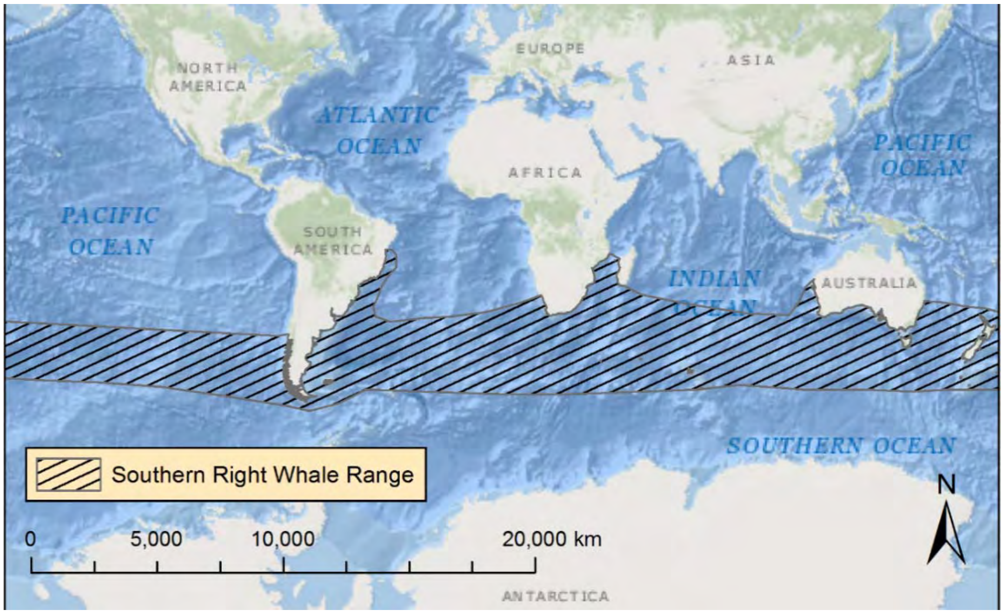


Figure 22. Map identifying the range of the endangered Southern right whale.

Southern right whales have a stocky, black body lacking a dorsal fin and a large head covered in callosities. They range in length between 13 to 17 m (43 to 56 ft), and weigh up to 54,431 kg (120,000 lb). The Southern right whale was listed as endangered under the Endangered Species Preservation Act on June 2, 1970, and this listing was carried over when the ESA was enacted (Table 46).

We used information available in the 2015 Status Review (NMFS 2015h) and the International Whaling Commission's 2012 Report on the Assessment of Southern Right Whales (IWC 2012b) to summarize the life history, population dynamics, and status of this species, as follows.

Life History

The lifespan of Southern right whales is currently unknown but likely similar to North Pacific and North Atlantic right whales, who are believed to live to around 50 years old. Females usually give birth to their first calf between eight and ten years old and gestation takes approximately one year. Offspring wean at approximately one year of age, and females reproduce every three to four years. Southern right whales feed during austral summer in high latitude feeding grounds in the Southern Ocean, where they use their baleen to "skim" copepods and krill from the water. Mating likely occurs in winter in the low latitude breeding and calving grounds.

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 southern right whale.

In 2010, there were an estimated 15,000 Southern right whales worldwide; this is over twice the species estimate of 7,000 in 1997. The population structure for southern right whales is uncertain, but some separation to the population level exists. Breeding populations can be delineate based on geographic region: South Africa, Argentina, Brazil, Peru and Chile, Australia, and New Zealand. Population estimates for all of the breeding populations are not available. There are about 3,500 southern right whales in the Australia breeding population, about 4,000 in Argentina, 4,100 in South Africa, and 2,169 in New Zealand. Other smaller southern right whale populations occur off Tristan da Cunha, South Georgia, Namibia, Mozambique and Uruguay, but not much is known about the population abundance of these groups.

The Australia, South Africa and Argentina breeding stocks of southern right whales are increasing at an estimated seven percent annually. The Brazil breeding population is increasing, while the status of the Peru and Chile breeding population is unknown (NMFS 2015h). The New Zealand breeding population is showing signs of recovery; recent population modeling estimates the population growth rate at 5.6 percent (Davidson 2016). Juveniles in New Zealand show high apparent annual survival rates, between 0.87 and 0.95 percent (Carroll et al. 2016).

Mitochondrial DNA analysis of Southern right whales indicates at least 37 unique haplotypes and greater genetic diversity in the South Atlantic Ocean than in the Indo-Pacific (Patenaude et al. 2007). Females exhibit high site fidelity to calving grounds, restricting gene flow and establishing geographic breeding populations. Recent genetic testing reveals the possibility that individuals from different ocean basins are mixing on the Antarctic feeding grounds (Kanda et al. 2014).

Southern right whales are found in the Southern Hemisphere from temperate to polar waters, favoring shallow waters less than twenty meters deep. Southern right whales migrate between winter breeding areas in coastal waters of the South Atlantic, Pacific, and Indian Oceans from May to December and offshore summer (January to April) foraging locations in the Subtropical and Antarctic Convergence zones (Figure 15).

Vocalization and Hearing

Data on Southern right whale vocalizations indicates that they exhibit similar acoustic behavior to other right whales (Clark 1982; Matthews et al. 2001a). 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 2002b; 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. 2005b).

Smaller groups vocalize more than larger groups and vocalization is more frequent at night (Matthews et al. 2001b). Moans are usually produced within 10 m (33 ft) of the surface (Matthews et al. 2001b). 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 µPa peak-to-peak (Hotchkin 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 top 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 µPa-m (rms), except for gunshots, which are 174 to 192 dB re: 1 µPa-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. 2005a; Parks et al. 2007b; 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. 2004c).

There is no direct data on the hearing range of Southern 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. 2007c).

Status

Southern right whales underwent severe decline due to whaling during the 18th and 19th centuries (NMFS 2015h). In general, Southern right whale populations appear to be increasing at a robust rate. Nonetheless, the current population estimate (15,000) is still much less than the estimated 60,000 pre-whaling estimate (NHT 2005). Southern right whales are currently subject to many of the same anthropogenic threats other large whales face. In the Southern Hemisphere, southern right whales are by far the most vessel struck cetacean, with at least 56 reported instances; nearly four-fold higher than the second most struck large whale (Van Waerebeek et al. 2007).

Additional threats include declines in water quality, pollutant exposure and near shore habitat degradation from development. Reproductive success is influenced by krill availability on the feeding grounds; therefore, climatic shifts that change krill abundance may hinder the recovery of Southern right whales (Seyboth et al. 2016). Because populations appear to be increasing in size, the species appears to be somewhat resilient to current threats, but it has not recovered to pre-exploitation abundance.

Critical Habitat

No critical habitat has been designated for the Southern right whale. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southern right whale. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

5.18 Sperm Whale

The sperm whale is a widely distributed found in all major oceans (Figure 23).

Figure 23: Map identifying the range of the endangered sperm whale.

Sperm whales are the largest toothed whale and distinguishable from other whales by its extremely large heard, which takes up to 25 to 35 percent of its total body length and a single blowhole asymmetrically situated on the left side of the head near the tip. The sperm whale was originally listed as endangered on December 2, 1970 (Table 46).

Information available from the recovery plan (NMFS 2010b), recent stock assessment reports (Carretta et al. 2017; Hayes et al. 2017; Muto et al. 2017), and status review (NMFS 2015i) were used to summarize the life history, population dynamics and status of the species as follows.

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 13 years of age for females with an average calving interval for 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).

Population Dynamics

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

The sperm whale is the most abundant of the large whale species, with total abundance estimates between 200,000 and 1,500,000. The most recent estimate indicated a global population of between 300,000 and 450,000 individuals (Whitehead 2009). The higher estimates may be approaching population sizes prior to commercial whaling, the reason for ESA listing. There are no reliable estimates for sperm whale abundance across the entire Atlantic Ocean. However, estimates are available for two to three U.S. stocks in the Atlantic Ocean, the Northern Gulf of Mexico stock, estimated to consists of 763 individuals (N_{min}=560) and the North Atlantic stock, underestimated to consist of 2,288 individuals (N_{min}=1,815). There are insufficient data to estimate abundance for the Puerto Rico and U.S. Virgin Islands stock. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the northeast Pacific Ocean, the abundance of sperm whales was estimated to be between 26,300 and 32,100 in 1997. In the eastern tropical Pacific Ocean, the abundance of sperm whales was estimated to be 22,700 (95 percent confidence intervals 14,800 to 34,600) in 1993. Population estimates are also available for two to three U.S. stocks that occur in the Pacific, the California/Oregon/Washington stock, estimated to consist of 2,106 individuals (N_{min}=1,332), and the Hawaii stock, estimated to consist of 3,354 individuals (N_{min}=2,539). There are insufficient data to estimate the population abundance of the North Pacific stock. We are aware of no reliable abundance estimates specifically for sperm whales in the South Pacific Ocean, and there is insufficient data to evaluate trends in abundance and growth rates of sperm whale populations at this time. There is insufficient data to evaluate trends in abundance and growth rates of sperm whales at this time.

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

Vocalization and Hearing

Sound production and reception by sperm whales are better understood than in most cetaceans. Sperm whales produce broadband 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 µPa), although lower source level energy has been suggested at around 171 dB re: 1 µPa (Goold and Jones 1995; Møhl et al. 2003; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997a). Most of energy in sperm whale clicks is concentrated at around 2 to 4 kHz and 10 to 16 kHz (Goold and Jones 1995; NMFS 2006d; Weilgart and Whitehead 1993). The highly asymmetric head anatomy of sperm whales is likely an adaptation to produce the unique clicks recorded from these animals (Cranford 1992; Norris and Harvey 1972; Norris and Harvey. 1972). Long, repeated clicks are associated with feeding and echolocation (Goold and Jones 1995; Weilgart and Whitehead 1993; Weilgart and Whitehead 1997a). 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. 1985a; Watkins and Schevill 1975b). 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).

Recordings of sperm whale vocalizations reveal that they produce a variety of sounds, such as clicks, gunshots, chirps, creaks, short trumpets, pips, squeals, and clangs (Goold 1999). Sperm whales typically produce short duration repetitive broadband clicks with frequencies below 100 Hz to greater than 30 kHz (Watkins 1977) and dominant frequencies between 1 to 6 kHz and 10 to 16 kHz. The source levels can reach 236 dB re: 1 µPa-m (Mohl et al. 2003). The clicks of neonate sperm whales are very different from typical clicks of adults in that they are of low directionality, long duration, and low frequency (between 300 Hz and 1.7 kHz) with estimated source levels between 140 to 162 dB re: 1 µPa-m (Madsen et al. 2003). Clicks are heard most frequently when sperm whales are engaged in diving and foraging behavior (Miller et al. 2004; Whitehead and Weilgart 1991). Creaks (rapid sets of clicks) are heard most frequently when sperm whales are foraging and engaged in the deepest portion of their dives, with inter-click intervals and source levels being altered during these behaviors (Laplanche et al. 2005; Miller et al. 2004).

When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Watkins and Schevill 1977). Codas are shared between individuals in a social unit and are considered to be primarily for intragroup communication (Rendell and Whitehead 2004; Weilgart and Whitehead 1997b). Recent research in the South Pacific Ocean suggests that in breeding areas the majority of codas are produced by mature females (Marcoux et al. 2006). Coda repertoires have also been found to vary geographically and are categorized as dialects, similar to those of killer whales (Pavan et al. 2000; Weilgart and Whitehead 1997b). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997b). For example, significant differences in coda repertoire have been observed between sperm whales in the Caribbean Sea and those in the Pacific Ocean (Weilgart and Whitehead 1997b). Three coda types used by male sperm whales have recently been described from data collected over multiple years: these codas associated with dive cycles, socializing, and alarm (Frantzis and Alexiadou 2008).

Direct measures of sperm whale hearing have been conducted on a stranded neonate using the auditory brainstem response technique: the whale showed responses to pulses ranging from 2.5 to 60 kHz and highest sensitivity to frequencies between five to 20 kHz (Ridgway and Carder 2001). Other hearing information consists of indirect data. For example, the anatomy of the sperm whale’s inner and middle ear indicates an ability to best hear high-frequency to ultrasonic hearing (Ketten 1992a). The sperm whale may also possess better low-frequency than other odontocetes, although not as low as many baleen whales (Ketten 1992a). Reactions to anthropogenic sounds can provide indirect evidence of hearing capability, and several studies have made note of changes seen in sperm whale behavior in conjunction with these sounds. For example, sperm whales have been observed to frequently stop echolocating in the presence of underwater pulses made by echosounders and submarine sonar (Watkins et al. 1985b; Watkins and Schevill 1975a). In the Caribbean Sea, Watkins et al. (1985b) observed that sperm whales exposed to 3.25 to 8.4 kHz pulses (presumed to be from submarine sonar) interrupted their activities and left the area. Similar reactions were observed from artificial noise generated by banging on a boat hull (Watkins et al. 1985b). André et al. (1997) reported that foraging whales exposed to a 10 kHz pulsed signals did not ultimately exhibit any general avoidance reactions: when resting at the surface in a compact group, sperm whales initially reacted strongly, and then ignored the signal completely (André et al. 1997). Thode et al. (2007) observed that the acoustic signal from the cavitation of a fishing vessel’s propeller (110 dB re: 1 µPa^{2} between 250 Hz and 1 kHz) interrupted sperm whale acoustic activity and resulted in the animals converging on the vessel. The full range of functional hearing for the sperm whale is estimated to occur between approximately 150 Hz and 160 kHz, placing them among the group of cetaceans that can hear mid-frequency sounds (Southall et al. 2007).

A sperm whale was tagged for a controlled exposure experiment during SOCAL BRS 2010. The sperm whale did not appear to demonstrate obvious behavioral changes in dive pattern or production of clicks (Miller et al. 2012b; Sivle et al. 2012; Southall et al. 2011b).

Status

The sperm whale is endangered as a result of past commercial whaling. Although the aggregate abundance worldwide is probably at least several hundred thousand individuals, the extent of depletion and degree of recovery of populations are uncertain. Commercial whaling is no longer allowed, however, illegal hunting may occur at biologically unsustainable levels. Continued threats to sperm whale populations include ship strikes, entanglement in fishing gear, competition for resources due to overfishing, population, 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.

Critical Habitat

No critical habitat has been designated for the sperm whale.

Recovery Goals

See the 2010 Final Recovery Plan for the sperm whale for complete downlisting/delisting criteria for both of the following recovery goals.

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

5.19 Bearded Seal – Okhotsk Distinct Population Segment

Two sub-species of bearded seals are recognized by NMFS: *Erignathus barbatus nauticus* in the Pacific Ocean and *Erignathus barbatus* in the Atlantic Ocean (Figure 24). Bearded seals in the Pacific Ocean are distributed from 85° North south to Sakhalin Island (45° North), including the Chukchi, Bering, and Okhotsk Seas.

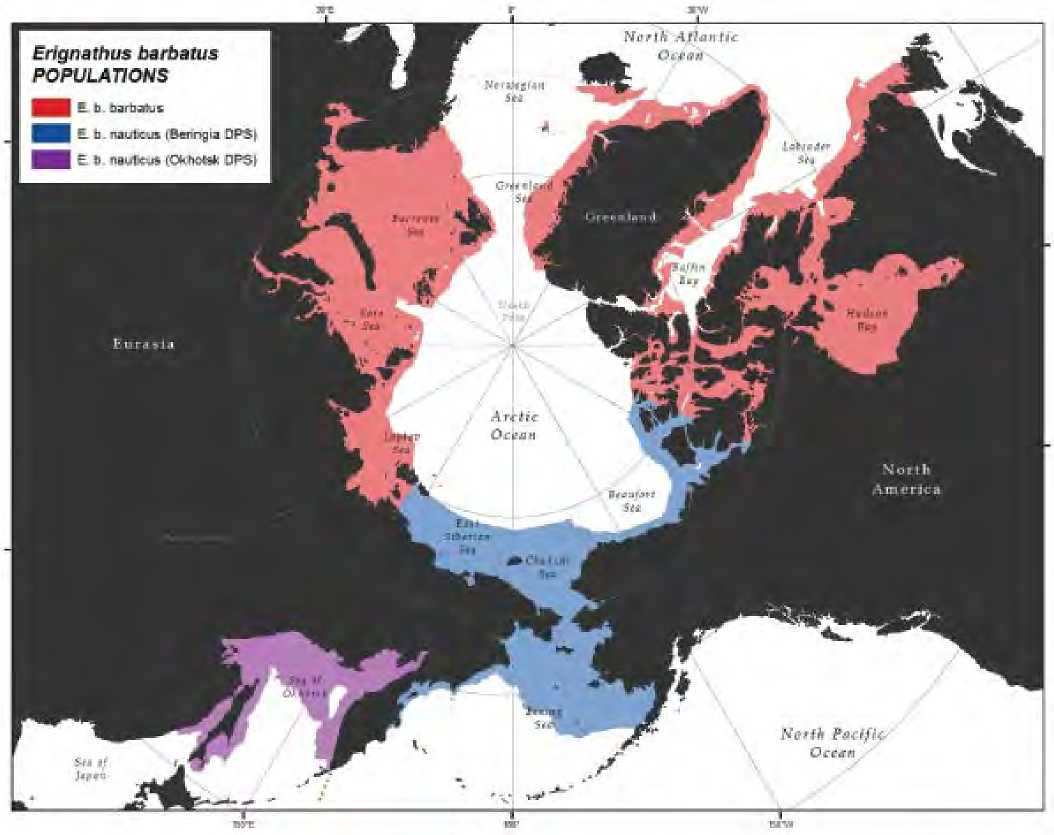


Figure 24. Map identifying the range of the two sub-species of bearded seal and the threatened Beringia and Okhotsk distinct population segments (Cameron et al. 2010).

Bearded seals are distinguished by their small head, small square foreflippers, and thick, long, white whiskers that have resulted in the name “bearded.” Pups have lighter markings on the face, resembling a “T” (Figure 24). The bearded seal is divided into two sub-species, with the Pacific Ocean sub-species further divided into two geographically and ecologically discrete DPSs, the Beringia DPS and the Okhotsk DPS. Only the Okhotsk DPS occurs within the action area.

We used information available in the final listing (77 FR 76740), the status review (Cameron et al. 2010), the recent stock assessment report (Muto et al. 2017) and available literature to summarize the status of the bearded seal, as follows.

Life History

Generally, bearded seals move north in late spring and summer, staying along the edge of the pack ice in summer, and then move south in the fall. Bearded seals can live up to 20 to 25 years old. Female bearded seals become sexually mature at five or six years of age, males at six or seven. Breeding occurs from March to July. Male bearded seals vocalize during the breeding season, with a peak in calling during and after pup rearing. These calls are likely used to attract females and defend their territories to other males (Cameron et al. 2010). Pups are born between mid-March and May, and are usually weaned in 15 days. Dependent pups spend about 50 percent of their time in the water. Nursing females spend more than 90 percent of their time in water, more than other large phocid seals. Bearded seals forage on a wide variety of benthic invertebrates, demersal fishes and sometimes, schooling fishes.

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 Okhotsk DPS of the bearded seal. The population size of the Okhotsk DPS is uncertain, but was thought to be approximately 95,000 at the time of the status review (Cameron et al. 2010). The population trend of the Okhotsk DPS of bearded seal is unknown. Incomplete abundance estimates make it impossible to assess trend information. There is some evidence to suggest a decreasing trend over time, but that assessment is not reliable due to inconsistent surveys (Cameron et al. 2010). There has been some study of the population structure of bearded seals, but it has not been possible to determine if Okhotsk DPS bearded seals are genetically distinct from other Pacific bearded seals (*E. b. nauticus*) (Cameron et al. 2010; Davis et al. 2008). The DPS determination was made on the basis that the Kamchatka Peninsula behaviorally isolates the breeding population in the Sea of Okhotsk. Bearded seals are boreoarctic with a circumpolar distribution and are closely associated with sea ice. Most bearded seals move seasonally, following the extent of the sea ice; however, some remain near the coasts during the summer and early fall. The Okhotsk DPS includes bearded seals found in the Sea of Okhotsk, Russia (Figure 24).

Vocalization and Hearing

Male bearded seals vocalize during the breeding season (March to July), with a peak in a calling during and after pup rearing. Their complex vocalizations range from 20 Hz to 11 kHz in frequency. These calls are likely used to attract females and defend their territories to other males (Cameron et al. 2010).

Status

The Okhotsk DPS of bearded seal has a large, apparently stable population size, which makes it resilient to immediate perturbations. It is, however, threatened by future climate change, specifically the loss of essential sea ice and change in prey availability, and as a result, is likely to become endangered in the future. Commercial harvest has depleted the bearded seal population in parts of the Sea of Okhotsk. Additional threats to the species include disturbance from vessels, sound from seismic exploration, and oil spills.

Critical Habitat

No designated critical habitat for the Okhotsk DPS of bearded seal; NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Okhotsk DPS of bearded seal. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

5.20 Guadalupe Fur Seal

Guadalupe fur seals were once found throughout Baja California, Mexico and along the California coast. Currently the species breed mainly on Guadalupe Island, Mexico, off the coast of Baja California. A smaller breeding colony, discovered in 1997, appears to have been established at Isla Benito del Este in the San Benito Archipelago, Baja California, Mexico (Belcher and T.E. Lee 2002) (Figure 25).

Figure 25. Map identifying the range of the threatened Guadalupe fur seal.

Guadalupe fur seals are medium sized, sexually dimorphic otariids (Belcher and T.E. Lee 2002; Reeves et al. 2002). Distinguishing characteristics of the Guadalupe fur seal include the digits on their hind flippers (all of similar length), large, long foreflippers, and unique vocalizations (Reeves et al. 2002). Guadalupe fur seals are dark brown to black, with the adult males having tan or yellow hairs at the back of their mane. Guadalupe fur seals were listed as threatened under the ESA on December 16, 1985 (Table 46).

Life History

Guadalupe fur seals prefer rocky habitats and can be found in natural recesses and caves (Fleischer 1978). Female Guadalupe fur seals arrive on beaches in June, with births occurring between mid-June to July (Pierson 1978); the pupping season is generally over by late July (Fleischer 1978). Females stay with pups for seven to eight days after parturition, and then alternate between foraging trips at sea and lactation on shore; nursing lasts about eight months (Figurereoa-Carranza 1994). Guadalupe fur seals feed mainly on squid species (Esperon-Rodriguez and Gallo-Reynoso 2013). Foraging trips can last between four to 24 days (average of 14 days). Tracking data show that adult females spend 75 percent of their time at sea, and 25 percent at rest (Gallo-Reynoso et al. 1995).

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 Guadalupe fur seal.

At the time of ESA-listing, the population was estimated at 1,600 individuals, compared to approximately 30,000 before hunting began. A population was "rediscovered" in 1928 with the capture of two males on Guadalupe Island; from 1949 on, researchers reported sighting Guadalupe fur seals at Isla Cedros (near the San Benito Archipelago), and Guadalupe Island (Bartholomew Jr. 1950; Peterson et al. 1968). In 1994, the population at Guadalupe Island was estimated at 7,408 individuals (Gallo-Reynoso 1994).

All Guadalupe fur seals represent a single population, with two known breeding colonies in Mexico, and purported breeding colony in the U.S. When the most recent stock assessment report for Guadalupe fur seals was published in 2000, the breeding colonies in Mexico were increasing; more recent evidence indicates that this trend is continuing (Aurioles-Gamboa et al. 2010; Esperon-Rodriguez and Gallo-Reynoso 2012). After compiling data from counts over 30 years, Gallo calculated that the population of Guadalupe fur seals in Mexico was increasing, with an average annual growth rate of 13.3 percent on Guadalupe Island (Gallo-Reynoso 1994). More recent estimates of the Guadalupe fur seal population of the San Benito Archipelago (from 1997 through 20007) indicates that it is increasing as well at an annual rate of 21.6 percent (Esperon-Rodriguez and Gallo-Reynoso 2012), and that this population is at a phase of exponential increase (Aurioles-Gamboa et al. 2010). The most recent NMFS stock assessment report states that Guadalupe fur seals are increasing at an average annual growth rate of 10.3 percent. Direct counts of animals at Isla Guadalupe and Isla San Benito during 2010 resulted in a minimum of 13,327 animals and 2,503 animals respectively, for a minimum population size of 15,830 animals (Carretta et al. 2017).

Bernardi et al. (1998) compared the genetic divergence in the nuclear fingerprint of samples taken from 29 Guadalupe fur seals, and found an average similarity of 0.59 of the DNA profiles. This average is typical of outbreeding populations. Although the relatively high levels of genetic variability are encouraging, it is important to note that commercial harvest still influenced the population. Later studies comparing mitochondrial DNA found in the bones of pre-exploitation Guadalupe fur seals against the extant population showed a loss of genotypes, with twenty-five genotypes in pre-harvest fur seals, and seven present today (Weber et al. 2004).

Guadalupe fur seals have been known to travel great distances, with sightings occurring thousands of kilometers away from the main breeding colonies (Aurioles-Gamboa et al. 1999). Guadalupe fur seals are infrequently observed in U.S. waters. They can be found on California's Channel Islands, with as many as 15 individuals being sighted since 1997 on San Miguel Island, including three females and reared pups.

Vocalization and Hearing

Though there has been no auditory assessment of the Guadalupe fur seal, its hearing likely falls within similar range as that of the Northern fur seal 2 to 40 kHz (Moore and Schusterman 1987).

Status

A number of human activities may have contributed to the current status of this species, historic commercial hunting was likely the most devastating. Commercial sealers in the 19th century decimated the Guadalupe fur seal population, taking as many as 8,300 fur seals from San Benito Island (Townsend 1924). The species was presumed extinct, until 1926, when a small herd was found on Guadalupe Island by commercial fishermen, who later returned and killed all that could be found. In 1954, during a survey of the island Hubbs (1956) discovered at least 14 individuals. Although population surveys occurred on an irregular basis in subsequent years, evidence shows that the Guadalupe fur seal has been increasing ever since. Although commercial hunting occurred in the past, and has since ceased, the effects of these types of exploitations persist today. Other human activities, such as entanglements from commercial fishing gear, are ongoing and continue to affect these species. Because that over the last 50 years the population has been increasing since being severely depleted, we believe that the Guadalupe fur seal population is resilient to future perturbations.

Critical Habitat

No critical habitat has been designated for the Guadalupe fur seal.

Recovery Goals

There has been no Recovery Plan prepared for Guadalupe fur seals.

5.21 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 and Main Hawaiian Islands (Figure 26).

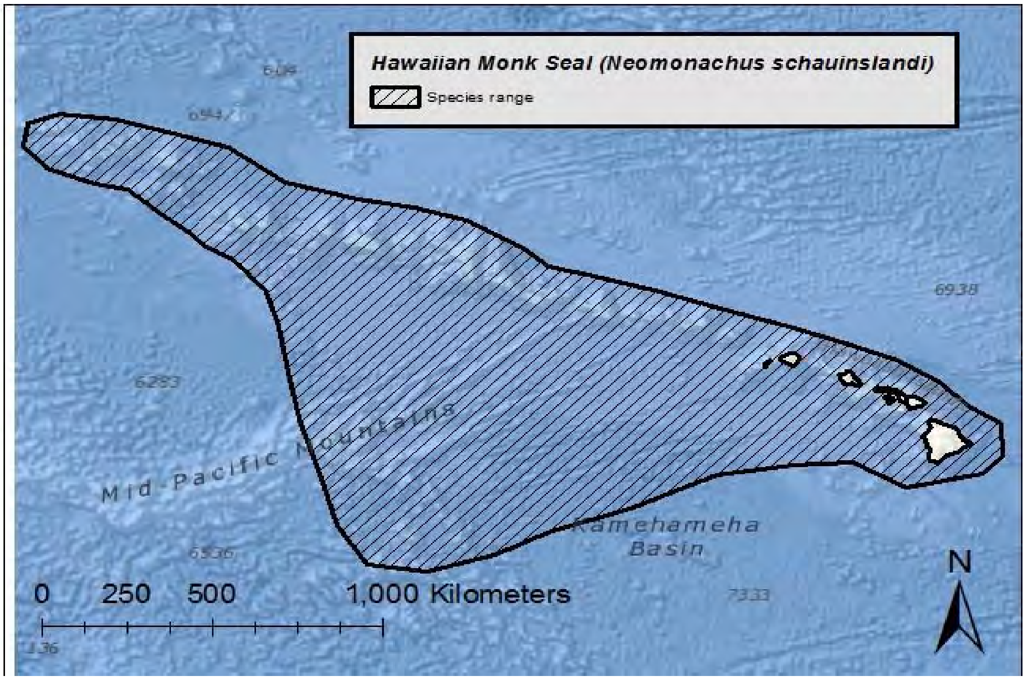


Figure 26. Map identifying the range of the endangered Hawaiian monk seal.

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.

Information available from the recovery plan (NMFS 2007d), recent stock assessment report (Carretta et al. 2017), and status review (NMFS 2007b) were used to summarize the life history, population dynamics, and status of the species as follows.

Life History

Hawaiian monk seals can live, on average, 25 to 30 years. Sexual maturity in females is reached around five 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 ten to eleven months, and calves nurse for approximately one month while the mother fasts and remains on land. After nursing, the mother abandons her pup and returns to sea for eight to ten 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 sub-photic zones either because there areas host favorable prey items or because these areas are less accessible by competitors (Parrish et al. 2000).

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 Hawaiian monk seal.

The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands and Main Hawaiian Islands. The entire range of the Hawaiian monk seal is located within U.S. waters. In addition to a small but growing population found on the Main Hawaiian Islands there are six main breeding sub-populations in the Northwestern Hawaiian Islands 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), although unpublished data indicate a larger population estimate of 1,400 (NMFS 2017c). The most recent NMFS stock assessment report has a minimum abundance estimate of 1,205 animals (N=1,272) for all sites combined (Carretta et al. 2017). 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. Current estimates indicate a growth rate of approximately 6.5 percent annually for the Main Hawaiian Islands sub-population (Baker et al. 2011). Likewise, sporadic beach counts at Necker and Nihoa Islands suggest a positive growth rate. The six main Northwestern Hawaiian Islands sub-populations continue to decline at approximately 3.4 percent annually.

Genetic analysis indicates the species is a single panmictic population, thus warranting a single stock designation (Schultz et al. 2011). 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 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.

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. 1995a; Richardson et al. 1995e;

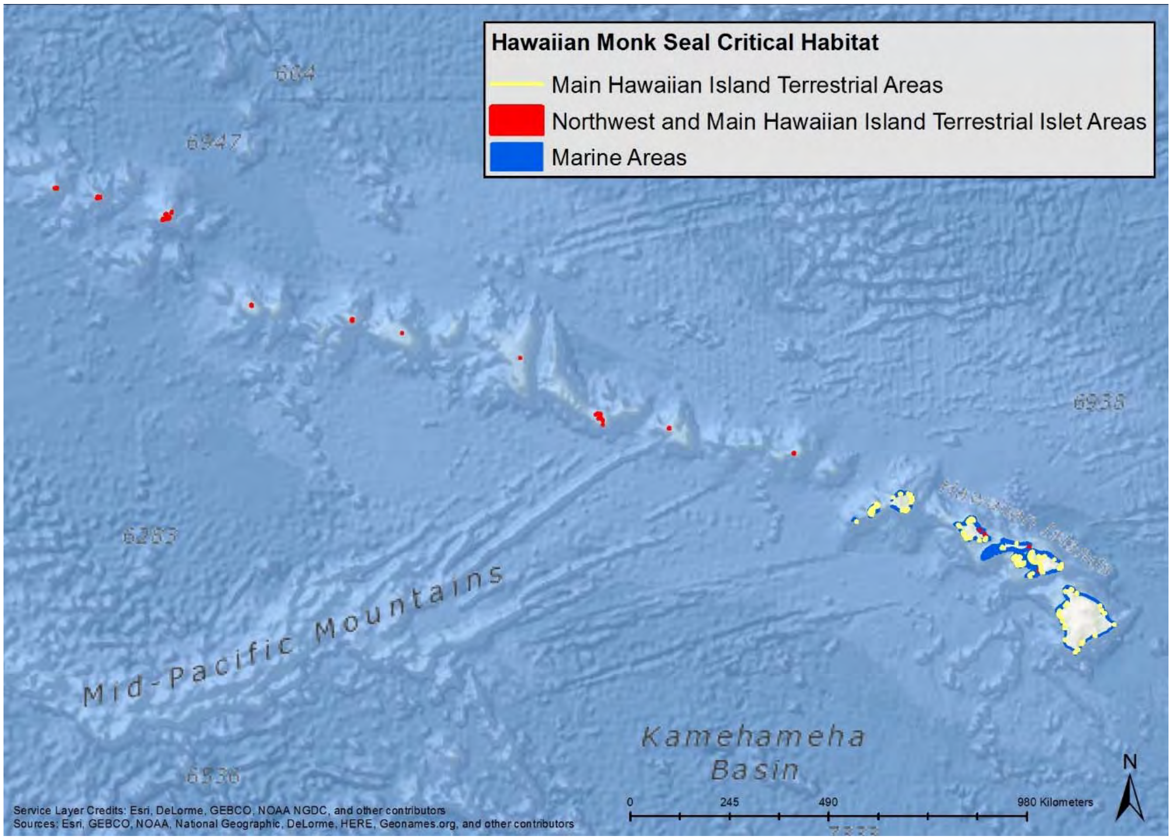
Thomas et al. 1990b). An underwater audiogram for Hawaiian monk seal, based on a single animals whose hearing may have been affected by disease or age, was best at 12 to 28 kHz and 60 to 70 kHz (Thomas et al. 1990b). The hearing showed relatively poor hearing sensitivity, as well as a narrow range of best sensitivity and a relatively low upper frequency limit (Thomas et al. 1990b). 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.

Status

Hawaiian monk seals were once harvested for their meat, oil, and skins, leading to extirpation in the main Hawaiian Islands 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 northwestern Hawaiian Islands 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 northwestern Hawaiian Islands, entanglement in marine debris, human interactions, loss of haul-out and pupping beaches due to erosion in northwestern Hawaiian Islands, disease outbreaks, shark predation, male aggression towards females, and low genetic diversity. With only 1,300 to 1,400 individuals remaining the species’ resilience to further perturbation is low.

Critical Habitat

Hawaiian monk seal critical habitat was originally designated on April 30, 1986 and was extended on May 26, 1988. It includes all beach areas, sand spits, and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of 37 m (121.4 ft) around the northwestern Hawaiian Islands breeding atolls and islands. The marine component of this habitat serves as foraging areas, while terrestrial habitat provides resting, pupping, and nursing habitat.



Service Layer Credits: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Figure 27: Map identifying designated critical habitat in the Northwest Hawaiian Islands and Main Hawaiian Islands for the endangered Hawaiian monk seal.

On September 21, 2015, NMFS published a final rule to revise designated critical habitat for Hawaiian monk seals, extending the current designation in the northwestern Hawaiian Islands out to the 200 m (656.2 ft) depth contour (including Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island). It also designated six new areas in the main Hawaiian Islands (i.e., terrestrial and marine habitat from 5 m [16.4 ft] inland from the shoreline extending seaward to the 200 m (656.2 ft) depth contour around Kaula, Niihau, Kauai, Oahu, Maui, Nui, and Hawaii).

Recovery Goals

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

1. Improve the survivorship of females, particularly juveniles, in sub-populations of the northwestern Hawaiian Islands.
2. Maintain the extensive field presence during the breeding season in the northwestern Hawaiian Islands.
3. Ensure the continued natural growth of the Hawaiian monk sea 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.

4. Reduce the probability of the introduction of infectious diseases into the Hawaiian monk seal population.

5.22 Mediterranean Monk Seal

Currently, there are two major concentrations of Mediterranean monk seals: one in the northeastern Mediterranean Sea around Greece and Turkey, and another in the northeastern Atlantic, including island of Madeira and the coast of Mauritania/Western Sahara in North Africa (i.e., the Cabo Blanco peninsula) (Figure 28).

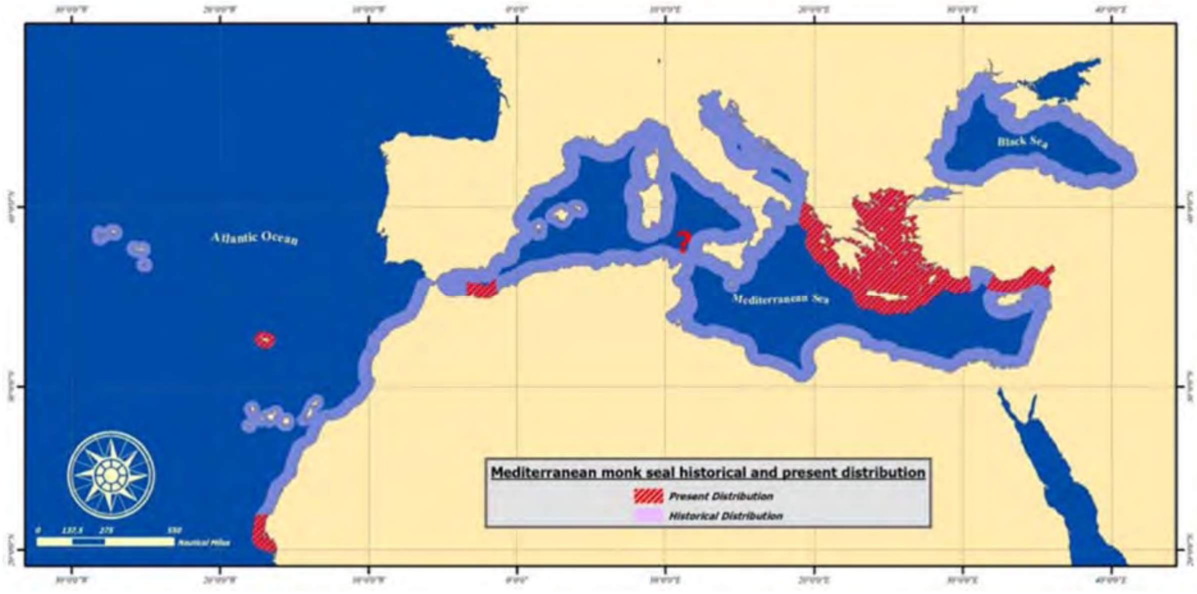


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Figure 28. Map identifying the range of the endangered Mediterranean monk seal (MOm (2014)).

Mediterranean monk seals are medium sized, sexually dimorphic phocid seals that are generally reclusive. Members of this species resemble Hawaiian monk seals, the only other remaining monk seal species. Distinguishing characteristics of the Mediterranean monk seal include its distinctive dark hood head and pale mask on its face, relatively short fore-flippers, and slender hind-flippers. Mediterranean monk seals have a brownish to grayish body with an extended, broad muzzle, relatively large, wide-spaced eyes, upward opening nostrils, and fairly big whisker pads. Mediterranean monk seals were listed as endangered under the ESA on June 2, 1970.

Information available from available scientific publications was used to summarize the life history, population dynamics and status of the species as follows.

Life History

Mediterranean monk seals occupy shallow coastal waters, but can make extended trips through deeper waters (CMS 2005; MOm 2014). Habitat in Greece tends to be rocky, isolated locations

(Azzolin et al. 2014; Sergeant et al. 1978). Unlike most other seal species, Mediterranean monk seals are known to haul-out in grottos or caves frequently accessible only by underwater entrances, possibly as a mechanism to offset human disturbance (Bareham and Furreddu 1975; Bayed et al. 2005; CMS 2005; Dendrinos et al. 2007).

Copulation occurs in the water outside of caves, which are aggressively defended by males, who mate with multiple females (CMS 2005; Pastor et al. 2011). Gestation is likely nine to ten months long (Marchessaux 1988). Adult females produce a single pup on roughly an annual to every third-year basis (CMS 2005; Gazo et al. 1999). The pupping season for the species varies over a broad geographical scale, and is possibly influenced by latitudinal differences – the Cabo Blanco peninsula lies at approximately 20° North, while Greece is at 39 to 40° North (Pastor and Aguilar 2003). Pupping occurs year-round for the colony at Cabo Blanco (Aguilar et al. 1995; Cedenilla et al. 2007; Gazo et al. 1999; Gonzalez et al. 1994; Pastor and Aguilar 2003). Pupping season for Mediterranean monk seals in Greek waters occur from August to December, with a peak in September to October (MOm 2014). During the first week postpartum, mothers remained with pups continuously, but started to leave pupping caves in the second week to forage (Aguilar et al. 2007; Gazo and Aguilar 2005).

Mediterranean monk seals forage on anchovies and pilchards, along with benthic cephalopods, fishes, and crustaceans (Boutiba and Abdelghani 1996; CMS 2005; Guclusoy 2008b; Karamanlidis et al. 2011; Pierce et al. 2011; Pierce et al. 2009; Salman et al. 2001; Sergeant et al. 1978). Individuals may travel for several days to foraging locations. Foraging dives for males averaged 25.5 m (83.7 ft) (maximum of 58 m [190.3 ft]) and averaged 3.5 minutes in duration (maximum of eight minutes) (CMS 2005; Gazo 1997). At Cabo Blanco, lactating females dove somewhat longer and deeper to an average depth of 28 to 38 m (91.9 to 124.7 ft) (maximum of 78 m [255.9 ft]) for an average of five to six minutes (CMS 2005; Gazo and Aguilar 2005). In Greek waters, seals may generally stay closer to their haul-out locations, and return to their caves each evening (Marchessaux and Duguy 1977).

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 Mediterranean monk seal.

Few than 600 individual Mediterranean monk seals are thought to survive at present (Alfaghi et al. 2013; Bundone et al. 2013), and may number 400 to 500 individuals (Azzolin et al. 2014). Major breeding centers along the eastern Atlantic at Desertas Islands (Madeira) and Cabo Blanco are believed to host fewer than 200 individuals in genetically isolated, restricted habitats (Anonymous 2001). The two major Atlantic groups, Madeira and Cabo Blanco, represent roughly half of all Mediterranean monk seals and are collectively believed to be about three percent of their former abundance (CMS 2005). Roughly 180 to 200 individuals live in Greek waters, making Greece one of the last strongholds for the species, with about 300 to 350 in the broader eastern Mediterranean Sea (MOm 2014).

There has been no comprehensive population growth rate estimated for the entire Mediterranean monk seal population, but researchers have examined the population dynamics of the individual colonies in Cabo Blanco, Madeira, and the eastern Mediterranean Sea. The Cabo Blanco population hosted about 300 individuals from the 1990's until 1997, when a major die-off took two-thirds of the population, significantly altering the colony's age structure. The current population trajectory of the colony is decreasing 3.5 percent annually, including the major die-off (CMS 2005). Excluding this mortality event, the colony seems to be recovering (Martinez-Jauregui et al. 2012). Roughly 150 individuals were believed to live here in 2005 (CMS 2005). Madeira (including Desertas Island), off the coast of Portugal, is thought to have once hosted about 1,600 individuals (Brito et al. 2006). By the 1970s, roughly 50 individuals are thought to have remained and continued to decline to six to eight individuals in the 1980s. The latest estimate in 2008 is that 20 to 30 individuals survive here (Pires et al. 2008). Pup production for the four known reproductive females has amounted to 35 individuals from 1989 through 2005, and annual birth rates have gradually increased over the same period. Population viability analysis suggests the risk of extinction along the Turkish coast is declining, but risks remain due primarily to mortality of adult females, skewed sex ration, 'Allee' effects, and inbreeding stress (Saydam et al. 2014).

Genetic diversity in the Cabo Blanco sub-population is one of the lowest of any pinniped population studies, losing roughly 53 percent of its heterozygosity (CMS 2005; Pastor et al. 2007; Pastor et al. 2004). However, inbreeding does not yet appear to be a problem (CMS 2005; Pastor et al. 2007). Genetic diversity in the Greek population is also low (Pastor et al. 2007).

Once stretching from the Azores and throughout the Mediterranean Sea, the Black Sea, and along the West African coast, Mediterranean monk seal distribution is now limited to isolated pockets. Populations in the Azores and the Black Sea are now considered extirpated. Mediterranean monk seals remain widely distributed in Greece (MOm 2014). Greece hosts the largest Mediterranean monk seal population (Adamantopoulou et al. 2000; Adamantopoulou et al. 2011), with small, isolated groups or individuals in other locations along with other concentrations along Mauritania on the Atlantic coast of Africa (Sergeant et al. 1978). Three islands off the coast of Madeira, Portugal, known as Desertas Islands, host an additional, isolated collection of a few monk seals (CMS 2005).

Vocalization and Hearing

Mediterranean monk seals produce two main aerial call types, barks and screams, which are individually specific (Charrier et al. 2017; Munoz et al. 2011). They also produce chirps, grunts, and short screams, and in captivity, pups produce squawks and gaggles (Charrier et al. 2017; Munoz et al. 2011). Calls range in frequency from 70 Hz to 3 kHz (Charrier et al. 2017). These calls are thought to be used in communication, but their specific function is unknown (Charrier et al. 2017). While no data on underwater vocalizations of Mediterranean monk seals exists, like Hawaiian monk seals, male Mediterranean monk seals are thought to produce underwater mating calls since breeding occurs in-water (Charrier et al. 2017). While we are aware of no empirical data on the hearing range of Mediterranean monk seals, their expected hearing range is between two and 40 kHz (Kellett et al. 2014; NOAA 2016a).

Status

Mediterranean monk seals were historically numerous but have been reduced to a small fraction of their former abundance and range due to human exploitation over the past six hundred years (Brito et al. 2006; Sergeant et al. 1978). Occurrence on open beaches generally ended due to exploitation during the 15th and 16th centuries (CMS 2005). Since exploitation for human use, monk seals were killed incidentally or intentionally as part of fisheries activities, with numerous reports of individuals killed throughout the present range of the species (CMS 2005; Gonzalez et al. 1993; Panou et al. 1993), notably in association with gill and bottom trawl nets (Gonzalez and Larrinoa 2013; Guclusoy 2008a) but also hand lines in Madeira (Hale et al. 2011). Sub-adults may be the age class most affected by entanglement (Karamanlidis et al. 2008). Although commercial hunting occurred in the past, and has since ceased, the effects of these types of exploitations persist today. Other human activities, such as habitat loss and entanglements from commercial fishing gear, are ongoing and continue to affect the species. Mediterranean monk seal populations have been severely depleted, and remain critically endangered. We believe that the Mediterranean monk seal population is not resilient to future perturbations.

Critical Habitat

No critical habitat has been designated for the Mediterranean monk seal. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Mediterranean monk seal. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.23 Ringed Seal – Arctic Distinct Population Segment

Ringed seals have widespread, circumpolar distribution, and are found throughout the Arctic Ocean, as well as the Sea of Okhotsk, Baltic Se, Lake Ladoga, and Lake Saimaa (Figure 30). There are five sub-species of ringed seals recognized: Ladoga (*P. h. ladogensis*), Saimaa (*P. h. saimensis*), Okhotsk (*P. h. ochotensis*), Baltic (*P. h. botnica*), and Arctic (*P. h. hispida*).

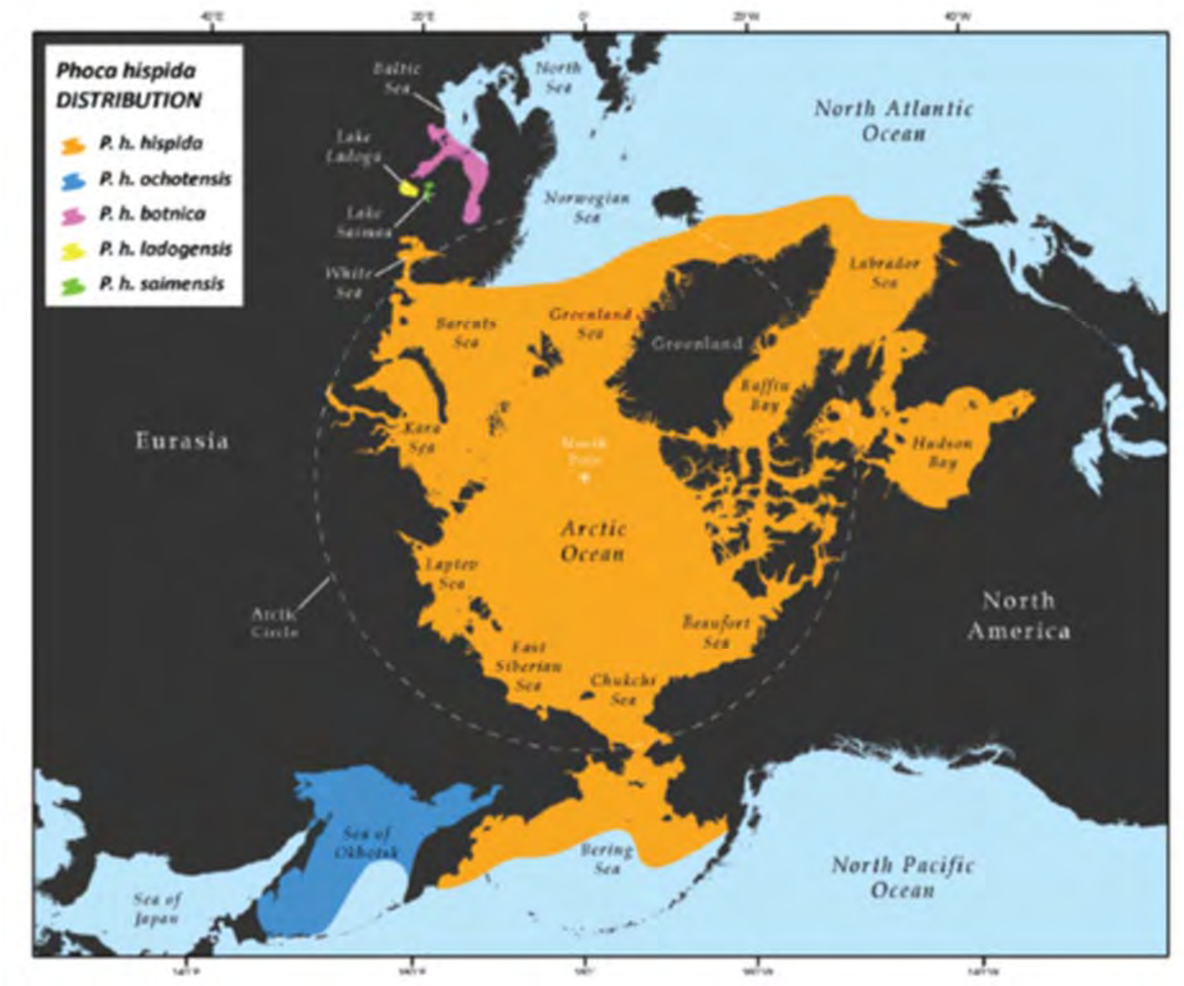

Figure 29. Map identifying the range of the five sub-species of ringed seal (Kelly et al. 2010b).

Ringed seals are the smallest of the Arctic seals. Adults can be up to 1.5 m (5 ft) and weight between 50 to 70 kg (110 to 150 lb). Their coat is variable, but is normally dark with light to silver rings that encircle spots along the back and sides and silver along the underside. They are distinguished by their small head: short, cat-like snout, and plump body. On December 28, 2012, NMFS issued a final determination to list the Arctic sub-species as threatened under the ESA (Table 46).

We used information available in the recent stock assessment report (Allen and Angliss 2014), the status review (Kelly et al. 2010a), ESA-listing documents, NMFS species information (NMFS 2015g), and available literature to summarize the status of the species, as follows.

Life History

Ringed seals are uniquely adapted to living on the ice. They use stout claws to maintain breathing holes in heavy ice, and excavate lairs in the snow cover above these holes to provide warmth and protection from predators while they rest, pup, and molt. The timing of breeding, whelping, and molting varies spatially and is dependent on the availability of sea ice, with populations at lower latitudes performing these activities earlier in the year. Females give birth in late winter to early spring to a single pup annually; they nurse for five to nine weeks and then the pup is weaned. During this time, pups spend an equal amount of time in the water and in the lair. Females reach sexual maturity at four to eight years of age, males at five to seven years of age. The average lifespan of a ringed seal is 15 to 28 years. They are trophic generalists, bur prefer small schooling prey that form dense aggregations (Kelly et al. 2010b). Ringed seals forage throughout the water column for a wide variety of prey items, from crustaceans to schooling fishes, though members of the cod family usually dominate their diet.

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 related to the Arctic DPS of ringed seal.

No reliable population estimates for the entire Arctic DPS of ringed seal population due to the species’ widespread distribution across political boundaries. In the status review, the population was estimated at approximately 2,000,000 individuals; however, NMFS considers this a crude estimate, as it relies on outdated data collected in a variety of ways and does not include all areas of its range. In the status review, the population of ringed seals in Alaska waters of the Chukchi and Beaufort Seas was estimated to be at least 300,000 individuals. This is most likely an underestimate of the true abundance because surveys in the Beaufort Sea were limited to within 40 km (21.6 nmi) of the shore (Kelly et al. 2010b).

Due to insufficient data, population trends for the Arctic sub-species cannot be calculated. It is unknown if the population is stable or fluctuating. The genetic population structure of the Arctic DPS of ringed seal is poorly understood. It is likely that population structuring exists in the species, but the extent to which it occurs is unknown.

Arctic DPS of ringed seals are widely distributed throughout the Arctic Ocean, in waters of Russia, Canada, Greenland, Finland, and the U.S. (Figure 29). In the U.S. waters, Arctic DPS of ringed seals are found around Alaska in the Bering, Chukchi, and Beaufort Seas. Most seals move seasonally, following the extent of the sea ice.

Vocalization and Hearing

Ringed seals produce underwater vocalizations ranging from approximately 100 Hz to 1 kHz (Jones et al. 2014). NMFS classifies ringed seals in the phocid pinniped functional hearing group. As a group, it is estimated that phocid pinnipeds can hear frequencies between 75 Hz and 100 kHz (NOAA 2013). Ringed seals can hear frequencies of 1 to 40 kHz (Blackwell et al. 2004a; Richardson et al. 1995a). Though they may be able to hearing frequencies above this limit (Terhune and Ronald 1976); their sensitivity to such sounds diminishes greatly above 45 kHz (Terhune and Ronald 1975). Direct studies of ringed seal hearing have not been conducted, but it is assumed that ringed seals can hear the same frequencies that they produce and are likely most sensitive to this frequency range (Richardson et al. 1995d).

Status

The Arctic ringed seal was listed as threatened under the ESA on December 28, 2012. The species is threatened due to climate change, especially from the expected loss of sea ice and snow cover in the foreseeable future. A final determination to list the Arctic sub-species of the ringed seal as threatened under the ESA went into effect on February 26, 2013. On March 11, 2016, the U.S. District Court for the District of Alaska issued a memorandum decision in a lawsuit challenging the listing of ringed seals under the ESA (Alaska Oil and Gas Association et al. v. National Marine Fisheries Service et al., Case No. 4: 14-cv-00029-RRB). The decision vacated NMFS's listing of the Arctic subspecies of ringed seals as a threatened species under the ESA. A notice of appeal of the U.S. District Court decision was filed on May 3, 2016. While the appeal is pending, our biological opinions will continue to address effects to ringed seals so that action agencies have the benefit of NMFS's analysis of the consequences of the proposed action on the species, even though the listing is not in effect.

Ringed seals are an important species for Alaska subsistence hunters. The most recent estimate of annual statewide harvest is from 2000 and was 9,567 ringed seals. The current level of subsistence harvest is not known and there are no efforts to quantify statewide harvest numbers. Additional threats to the species include fisheries interactions (including entanglement), disturbance from vessel, sound from seismic exploration, and oil spills.

Because of their apparently large population size and the long-term nature of the threat of climate change to the species, ESA section 4(d) protective regulations and section 9 prohibitions were deemed unnecessary for the conservation of the species at the time of listing.

In summary, the Arctic ringed seal has an apparently large population, making it resilient to immediate perturbations. However, threatened by climate change in the long-term, the species is likely to become endangered in the future.

Critical Habitat

Critical habitat for Arctic DPS of ringed seals was proposed for designation in the Bering, Chukchi, and Beaufort Seas in Alaska. Physical or biological features essential to the conservation of the species included sea ice habitat suitable for the formation of and maintenance of subnivean birth lairs, sea ice habitat suitable as a platform for basking and molting, and primary prey resources to support Arctic DPS of ringed seals.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Arctic DPS of ringed seal.

5.24 Ringed Seal – Okhotsk Distinct Population Segment

Ringed seals have widespread, circumpolar distribution, and are found throughout the Arctic Ocean, as well as the Sea of Okhotsk, Baltic Se, Lake Ladoga, and Lake Saimaa (Figure 30). There are five sub-species of ringed seals recognized: Ladoga (*P. h. ladogensis*), Saimaa (*P. h. saimensis*), Okhotsk (*P. h. ochotensis*), Baltic (*P. h. botnica*), and Arctic (*P. h. hispida*).

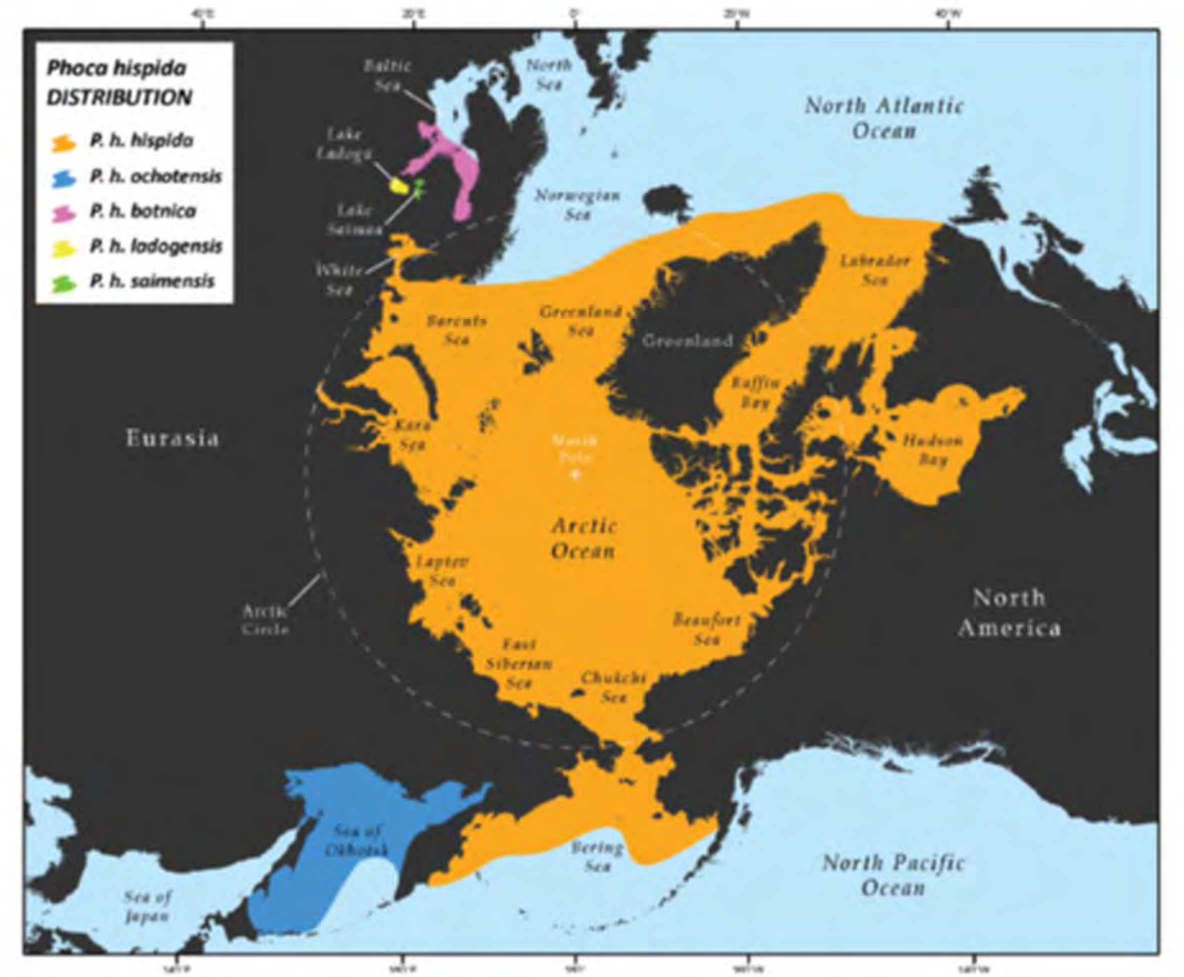

Figure 30. Map identifying the range of the five sub-species of ringed seal (Kelly et al. 2010b).

Ringed seals are the smallest of the Arctic seals. Adults can be up to 1.5 m (5 ft) and weight between 50 to 70 kg (110 to 150 lb). Their coat is variable, but is normally dark with light to silver rings that encircle spots along the back and sides and silver along the underside. They are distinguished by their small head: short, cat-like snout, and plump body. On December 28, 2012, NMFS issued a final determination to list the Okhotsk sub-species as threatened under the ESA (Table 46).

We used information available in the recent stock assessment report (Allen and Angliss 2014), the status review (Kelly et al. 2010a), ESA-listing documents, NMFS species information (NMFS 2015g), and available literature to summarize the status of the species, as follows.

Life History

Ringed seals are uniquely adapted to living on the ice. They use stout claws to maintain breathing holes in heavy ice, and excavate lairs in the snow cover above these holes to provide warmth and protection from predators while they rest, pup, and molt. The timing of breeding, whelping, and molting varies spatially and is dependent on the availability of sea ice, with populations at lower latitudes performing these activities earlier in the year. Females give birth in late winter to early spring to a single pup annually; they nurse for five to nine weeks and then the pup is weaned. During this time, pups spend an equal amount of time in the water and in the lair. Females reach sexual maturity at four to eight years of age, males at five to seven years of age. The average lifespan of a ringed seal is 15 to 28 years. They are trophic generalists, bur prefer small schooling prey that form dense aggregations (Kelly et al. 2010b). Ringed seals forage throughout the water column for a wide variety of prey items, from crustaceans to schooling fishes, though members of the cod family usually dominate their diet.

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 related to the Okhotsk DPS of ringed seal.

The ringed seal has a widespread, circumpolar distribution and their population structure is poorly understood. It is likely that population structuring exists in the species, but the extent to which it occurs is not yet known.

Arctic ringed seals are widely distributed throughout the Arctic Ocean, in waters of Russia, Canada, Greenland, Finland, and the U.S. (Figure 30). Okhotsk DPS ringed seals occupy the Sea of Okhotsk bordering Russia and Japan (Figure 30). There is no reliable population trend information for the Okhotsk DPS of ringed seal. There is no available information on the genetic diversity of Okhotsk DPS of ringed seal. Most ringed seals move seasonally, following the extent of the sea ice.

No reliable population estimates for the entire Arctic ringed seal population exist due to the species' widespread distribution across political boundaries. In the status review, the population was estimated at approximately 2,000,000 individuals; however, NMFS considers this a crude estimated, as it relies on outdated data collected in a variety of ways and does not include all areas of its range.

Vocalization and Hearing

Ringed seals produce underwater vocalizations ranging from approximately 100 Hz to 1 kHz (Jones et al. 2014). NMFS classifies ringed seals in the phocid pinniped functional hearing group. As a group, it is estimated that phocid pinnipeds can hear frequencies between 75 Hz and 100 kHz (NOAA 2013). Ringed seals can hear frequencies of 1 to 40 kHz (Blackwell et al. 2004a; Richardson et al. 1995a). Though they may be able to hearing frequencies above this limit (Terhune and Ronald 1976); their sensitivity to such sounds diminishes greatly above 45 kHz (Terhune and Ronald 1975). Direct studies of ringed seal hearing have not been conducted, but it is assumed that ringed seals can hear the same frequencies that they produce and are likely most sensitive to this frequency range (Richardson et al. 1995d).

Status

Additional threats to the species include fisheries interactions (including entanglement), disturbance from vessels, noise from seismic exploration, and oil spills. Because of their apparently large population size and the long-term nature of the threat of climate change to the species, ESA section 4(d) protective regulations and section 9 prohibitions were deemed unnecessary for the conservation of the species at the time of ESA-listing.

Conservative estimates for the Okhotsk DPS of ringed seal place the population abundance at 676,000 (Kelly et al. 2010b). Russia permits subsistence hunting and for commercial purposes, but the overall take is thought to be minimal (Kelly et al. 2010b). The Okhotsk DPS of ringed seal has an apparently large population, making it resilient to immediate perturbations. However, threatened by climate change in the long-term, the species is likely to become endangered in the future.

Critical Habitat

No critical habitat has been designated for the Okhotsk DPS of ringed seal. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Okhotsk DPS of ringed seal. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.25 Spotted Seal – Southern Distinct Population Segment

Spotted seals in the Pacific are distributed from 85° North south to Sakhalin Island (45° North), including the Chukchi, Bering, and Okhotsk Seas. Eight breeding areas throughout the range of the spotted seal have been identified (Figure 31).

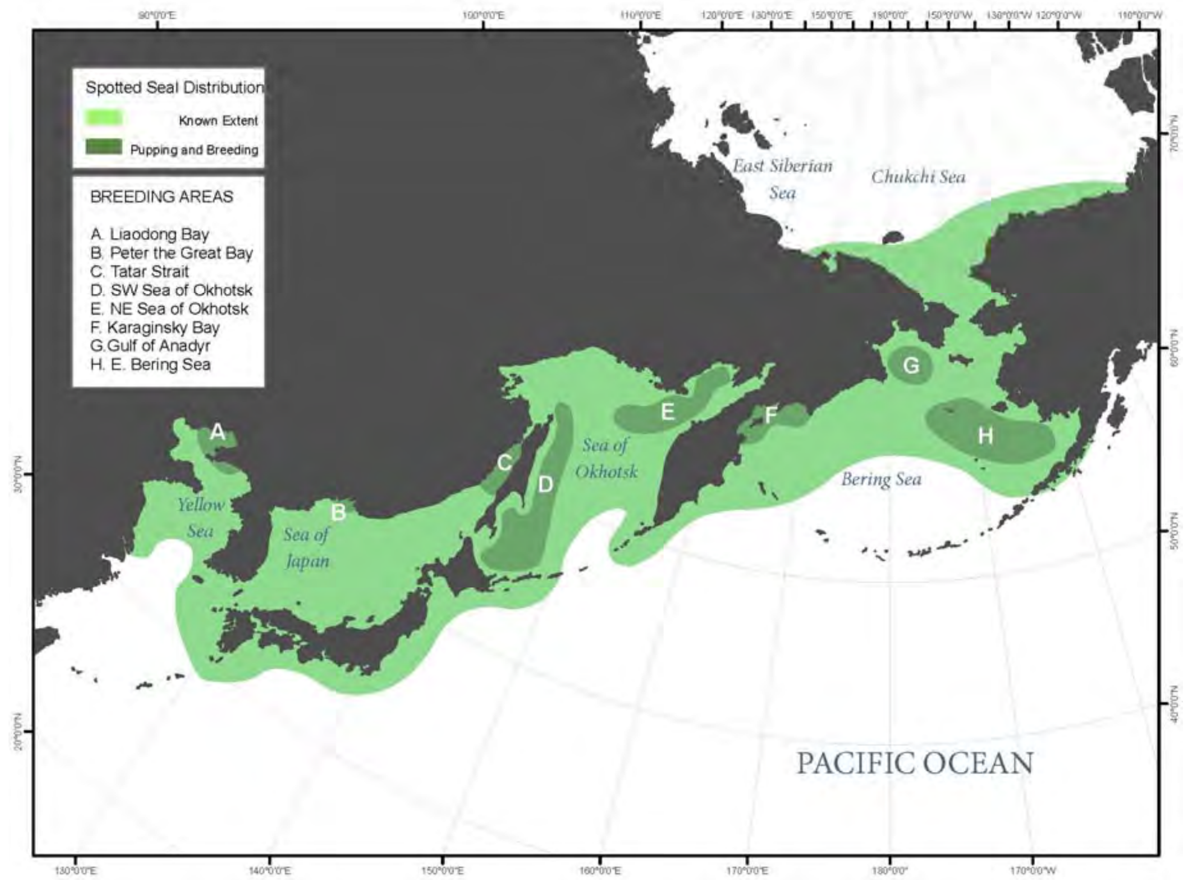

Figure 31. Map identifying the range, pupping, and breeding areas of the spotted seal. Breeding areas A and B (Liaodong Bay and Peter the Great Bay) comprise the Southern distinct population segment of spotted seal (Boveng et al. 2009b).

Spotted seals have a silver to light gray coat with dark spots. Adult can be up to 1.5 m (5 ft) and weigh between 65 to 115 kg (140 to 250 lb). The spotted seal is divided into three DPSs: the Southern DPS, the Bering Sea DPS, and the Sea of Okhotsk DPS. The Southern DPS is composed of spotted seals breeding in the Liaodong Bay, Yellow Sea, and Peter the Great Bay in the Sea of Japan. On October 22, 2010, the NMFS issued a final determination to list the Southern DPS as threatened under the ESA (Table 46).

We used information available in the final listing, the status review (Boveng et al. 2009b) and available literature to summarize the status of the Southern DPS of spotted seal, as follows.

Life History

Spotted seals can live up to 30 to 35 years old. Most spotted seals are sexually mature by age four. Spotted seals haul out onto the sea ice to breed; the timing of breeding depends on the region. Breeding in Liaodong Bay occurs from February to mid-March and in March and April in the Peter the Great Bay. The implantation of the fertilized embryo is delayed by two to four months, and gestation lasts seven to nine months. Pups are born between early January to mid-February in Liaodong Bay, and between early February and mid-March in peter the Great Bay.

Pups are usually weaned in three to four weeks. Nursing pups do not enter the water until they are weaned and molted. They are dependent on the sea ice until they learn to dive and forage for themselves, which usually occurs ten to 15 days after molting. After breeding and birthing, the herds break up to migrate in spring and summer towards open water for favorable foraging grounds. Adult spotted seals forage on a wide variety of fishes like Pacific herring, Japanese smelt and capelin. Juveniles eat krill and small crustaceans. While foraging, spotted seals generally stay in continental shelf waters up to 200 m (656.2 ft) deep (Boveng et al. 2009b).

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 Southern DPS of the spotted seal.

Due to the logistical difficulties of surveying ice seals in remote areas, there is some uncertainty surrounding abundance estimates for the Southern DPS of spotted seal. For the Southern DPS as a whole, the population could number as many as 3,500 individuals. The breeding population in Liaodong Bay was estimated at 1,000 individuals from 2005 through 2008 (Han et al. 2010) and about 800 individuals in 2007 (Boveng et al. 2009b). The most recent abundance estimate for the Peter the Great Bay breeding population is 2,500 spotted seals in the spring, with about 300 pups produced annually (Boveng et al. 2009b).

Population trends are not available at this time for the Southern DPS of spotted seal. Available information for the breeding population in Liaodong Bay indicate that the population there has fluctuated from a maximum of 8,137 individuals in 1940 to as few as 700 in 2007 (75 FR 65239).

There has been some study of the population structure of Southern DPS of spotted seals. (Han et al. 2010) found low levels of genetic diversity in the Liaodong Bay breeding colony, likely the result of a population reduction over the past several decades.

Spotted seals are found in the North Pacific Ocean, preferring arctic and sub-arctic waters and are closely associated with outer margins of sea ice. Spotted seals in the Southern DPS are found in the Yellow Sea and Sea of Japan (Figure 31). Most seals move seasonally, following the extent of the sea ice.

Vocalization and Hearing

Five distinct sounds have been identified in captive spotted seals of both sexes: growls, drums, snorts, chirps, and barks that range in frequency from 500 Hz to 3.5 kHz (Beier and Wartzok 1979; Richardson et al. 1995a). A "creaky door sound" has only been recorded from males (Beier and Wartzok 1979). A recent study on wild spotted seals in Liaodong Bay, China identified four major call types (knocks, growls, drums, and seeps), some of which are similar to those previously mentioned for captive animals (Yang et al. 2017). These calls also appeared to be similar to the closely related harbor seal (*Phoca vitulina*), and consist of short, low frequency (less than 600 Hz) sounds (Yang et al. 2017). Little is known about the hearing of spotted seals. Recently, Sills et al. (2014) measured the underwater and in-air hearing capabilities of young spotted seals and found that the best hearing sensitivity in air spanned four octaves, ranging from approximately 0.6 to 11 kHz, while the hearing sensitivity underwater ranged from 0.3 and 56 kHz. Sills et al. (2014) concluded that the sound reception capabilities of spotted seals differ from those described previously for ice seals, with capabilities more similar to harbor seals.

Status

Commercial harvesting in the 19th and 20th centuries depleted Southern DPS of spotted seals. In Peter the Great Bay, as many as 80 or more spotted seals per day were harvested in the late 19th century. Populations in Liaodong Bay were also heavily impacted by hunting; about 30,000 spotted seals were harvested in the Yellow Sea from 1930 through 1990 (Boveng et al. 2009b). Bycatch in fishing nets and shooting by fishermen are considered to be the greatest current threats to Southern DPS of spotted seals. In addition, the species is threatened by future climate change, specifically the loss of essential sea ice and change in prey availability. Even though spotted seals in Liaodong Bay and Peter the Great Bay can breed and molt on land, a loss of sea ice habitat will reduce suitable space for reproduction and rearing. As a result, is likely to become endangered in the future.

Critical Habitat

No designated critical habitat for the Southern DPS of spotted seal; NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southern DPS of spotted seal. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.26 Steller Sea Lion – Western Distinct Population Segment

The Steller sea lion ranges from Japan, through the Okhotsk and Bering Seas, to central California. It consists of two morphologically, ecologically, and behaviorally separate DPSs: the Eastern, which includes sea lions in Southeast Alaska, British Columbia, Washington, Oregon, and California; and the Western, which includes sea lions in all other regions of Alaska, as well as Russia and Japan (Figure 32).

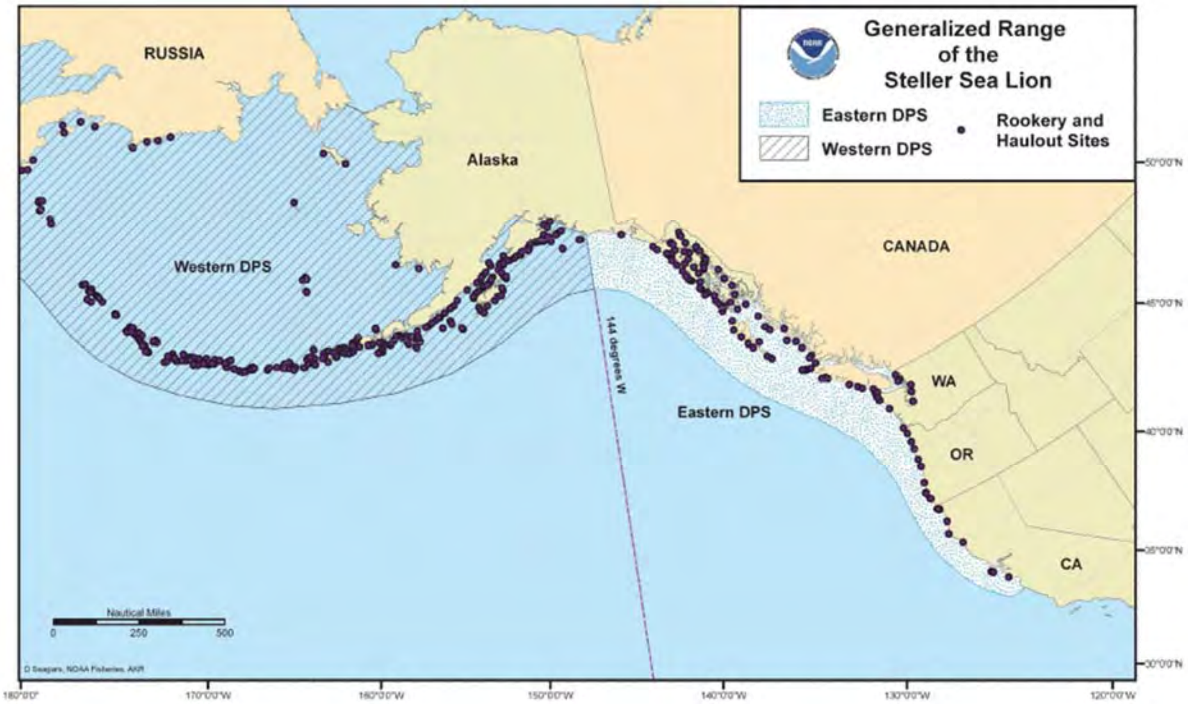

Figure 32. Map identifying the range of the endangered Western distinct population segment of Steller sea lion.

Steller sea lion adults are light blonde to reddish brown and slightly darker on the chest and abdomen. At the time of their initial listing, Steller sea lions were considered a single population listed as threatened. On May 5, 1997, following a status review, NMFS established two DPSs of Steller sea lions, and issued a final determination to list the Western DPS as endangered under the ESA. The Eastern DPS was delisted on November 4, 2013, and the Western DPS retained its endangered status (78 FR 66139) (Table 46).

We used information available in the final listing, the revised Recovery Plan (NMFS 2008c), and the most recent stock assessment report (Muto et al. 2017) to summarize the status of the Western DPS of Steller sea lions, as follows.

Life History

Within the Western DPS of Steller sea lions, pupping and breeding occurs at numerous major rookeries from late May to early July. Male Steller sea lions become sexually mature at three to seven years of age. They are polygynous, competing for territories and females by age ten or eleven. Female Steller sea lions become sexually mature at three to six years of age and reproduce into their early 20's. Most females breed annually, giving birth to a single pup. Pups are usually weaned in one to two years. Females and their pups disperse from rookeries by August to October. Juveniles and adults disperse widely, especially males. Their large aquatic ranges are used for foraging, resting, and traveling. Steller sea lions forage on a wide variety of demersal, semi-demersal, and pelagic prey, including fish and cephalopods. Some prey species form large seasonal aggregations, including endangered salmon and eulachon species. Others are available year round.

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 DPS of the Steller sea lion.

As of 2015, the best estimate of abundance of the Western DPS of Steller sea lion in Alaska was 12,189 pups and 37,308 for non-pups (total N_{min}=49,497) (Muto 2016). The most recent NMFS stock assessment report had a total best estimate and minimum population estimate of 50,983 animals (Muto et al. 2017). This represents a large decline since counts in the 1950s (N=140,000) and 1970s (N=110,000). The population of entire DPS is 68,218 (49,497 for U.S. stock and 18,721 for Asian stock)

Steller sea lion Western DPS site counts decreased 40 percent from 1991 through 2000, an average annual decline of 5.4 percent; however, counts increased three percent between 2004 through 2008, the first recorded population increase since the 1970s (NMFS 2008c). However, there are regional differences in population growth rate, with positive trends in the eastern portion of the range, and negative trends west of Samalga Pass (approximately 170° West) (Muto 2016). These trends indicate that overall, the Western DPS may be stable or exhibiting a slight negative trend as a whole.

Based on the results of genetic studies, the Steller sea lion population was reclassified into two DPSs: Western and Eastern. The data which came out of these studies indicated that the two populations had been separate since the last ice age (Bickham et al. 1998). Further examination of the Steller sea lions from the Gulf of Alaska (i.e., the Western DPS) revealed a high level of haplotypic diversity, indicating that genetic diversity had been retained despite the decline in abundance (Bickham et al. 1998).

Steller sea lions are distributed mainly around the coats to the outer continental shelf along the North Pacific Ocean rim from northern Hokkaido, Japan through the Kuril Islands and Okhotsk Sea, Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California (Figure 32). The Western DPS includes Steller sea lions that reside in the central and western Gulf of Alaska, Aleutian Islands, as well as those that inhabit the coastal waters and breed in Asia (e.g., Japan and Russia).

Vocalization and Hearing

Steller sea lions hear within the range of 0.5 to 32 kHz (Kastelein et al. 2005). Males and females apparently have different hearing sensitivities, with males hearing best at 1 to 16 kHz (best sensitivity at the low end of the range) and females hearing from 16 to 25 kHz (best hearing at the upper end of the range) (Kastelein et al. 2005).

Status

The species was ESA-listed as threatened in 1990 because of significant declines in population sizes. At the time, the major threat to the species was thought to be reduction in prey availability. To protect and recover the species, NMFS established the following measures: prohibition of shooting at or near Steller sea lions; prohibition of vessel approach to within 5.6 km (3 nmi) of specific rookeries, within 0.8 km (0.4 nmi) of land, and within sight of other listed rookeries; and restriction of incidental fisheries take to 675 Steller sea lions annually in Alaskan waters. In 1997, the Western DPS was reclassified as endangered because it had continued to decline since its initial ESA-listing in 1990. Despite the added protection (and annual incidental fisheries take of 26 individuals), the Western DPS of Steller sea lions is likely still in decline (though the decline was slowed or stopped in some portions of the range). The reasons for the continued decline are unknown but may be associated with nutritional stress as a result of environmental change and competition with commercial fisheries. The Western DPS of Steller sea lions appears to have little resilience to future perturbations.

Critical Habitat

In 1997, NMFS designated critical habitat for the Steller sea lion. The designated critical habitat includes specific rookeries, haul-outs, and associated areas, as well as three foraging areas that are considered to be essential for health, continued survival, and recovery of the species.

Figure 33: Map depicting Alaskan designated critical habitat for the Western distinct population segment of Steller sea lion.

In Alaska, areas include major Steller sea lion rookeries, haul-outs and associated terrestrial, air, and aquatic zones (Figure 33). Designated critical habitat includes a terrestrial zone extending 0.9 km (0.5 nmi) landward from each major rookery and haul-out; it also includes air zones extending 0.9 km above these terrestrial zones and aquatic zones. Aquatic zones extend 0.9 km (0.5 nmi) seaward from the major rookeries and haul-outs east of 144° West. In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikof Strait (in the Gulf of Alaska), Bogoslof Island, and Seaguam Pass (the latter two are in the Aleutians). These sites are located near Steller sea lion abundance centers and include important foraging areas, large concentrations of prey, and host large commercial fisheries that often interact with the species.

Although within the range of the now delisted Eastern DPS, the designated critical habitat in California and Oregon remains in effect (78 FR 66139). In California and Oregon, major Steller sea lion rookeries and associated air and aquatic zones are designated as critical habitat. Designated critical habitat includes an air zone extending 0.9 km (0.5 nmi) above rookery areas historically occupied by Steller sea lions. Designated critical habitat also includes an aquatic zone extending 0.9 km (0.5 nmi) seaward.

Recovery Goals

See the 2008 Revised Recovery Plan for the Steller sea lion for complete downlisting/delisting criteria for each of the following recovery goals.

1. Baseline population monitoring.
2. Insure adequate habitat and range for recovery
3. Protect from over-utilization for commercial, recreational, scientific, or educational purposes.
4. Protect from diseases, contaminants, and predation.
5. Protect from other natural or anthropogenic actions and administer the recovery program.

5.27 Green Turtle – Central 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 34).

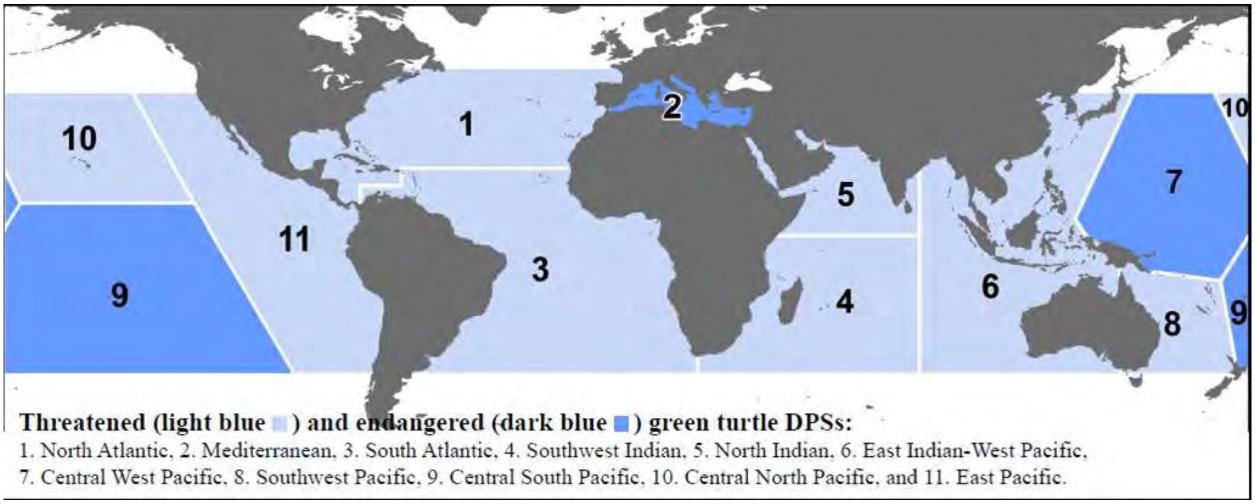

Figure 34. Map depicting range and distinct population segment boundaries for green turtles.

The Central North Pacific DPS of green turtle is found in the Pacific Ocean near the Hawaiian Archipelago and Johnston Atoll (Figure 35).

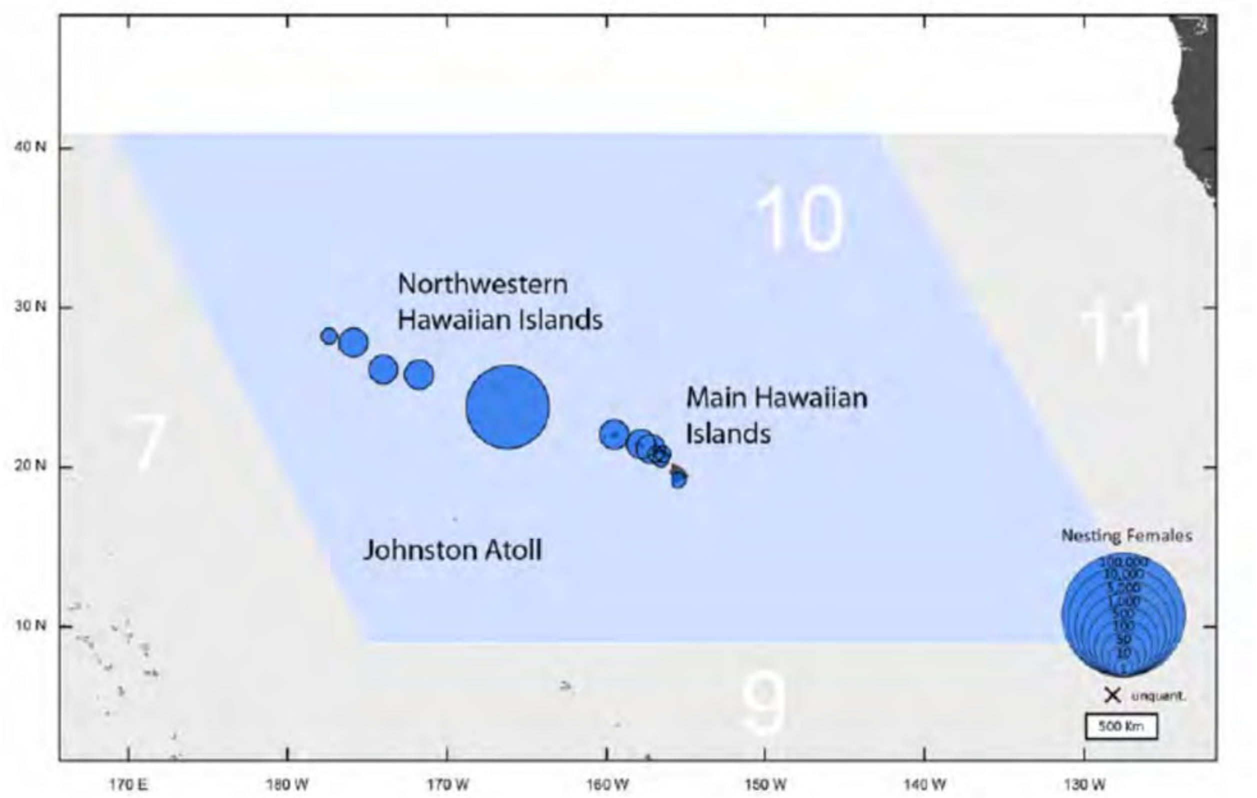

Figure 35. Geographic range of the Central North Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Central North Pacific DPS is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). There are 13 known nesting sites for the Central North Pacific DPS, with an estimated 3,846 nesting females. The DPS is very thoroughly monitored, and it is believed there is little chance that there are undocumented nesting sites. The largest nesting site is at French Frigate Shoals, Hawaii, which hosts 96 percent of the nesting females for the Central North Pacific DPS (Seminoff et al. 2015). Nesting surveys have been conducted since 1973. Nesting abundance at East Island, French Frigate Shoals, increases at 4.8 percent annually (Seminoff et al. 2015).

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 et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles in the Central North Pacific DPS are found in the Hawaiian Archipelago and Johnston Atoll (Figure 35). The major nesting site for the Central North Pacific DPS is at East Island, French Frigate Shoals, in the Northwestern Hawaiian Islands; lesser nesting sites are found throughout the Northwestern Hawaiian Islands and the Main Hawaiian Islands.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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.

Critical Habitat

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

Recovery Goals

See the 1998 and 1991 recovery plans for the Pacific, East Pacific, and Atlantic populations of green turtles for complete downlisting/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

5.28 Green Turtle – Central South 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 34). The Central South Pacific DPS of green turtle is found in the South Pacific Ocean throughout several island groups (Figure 36).

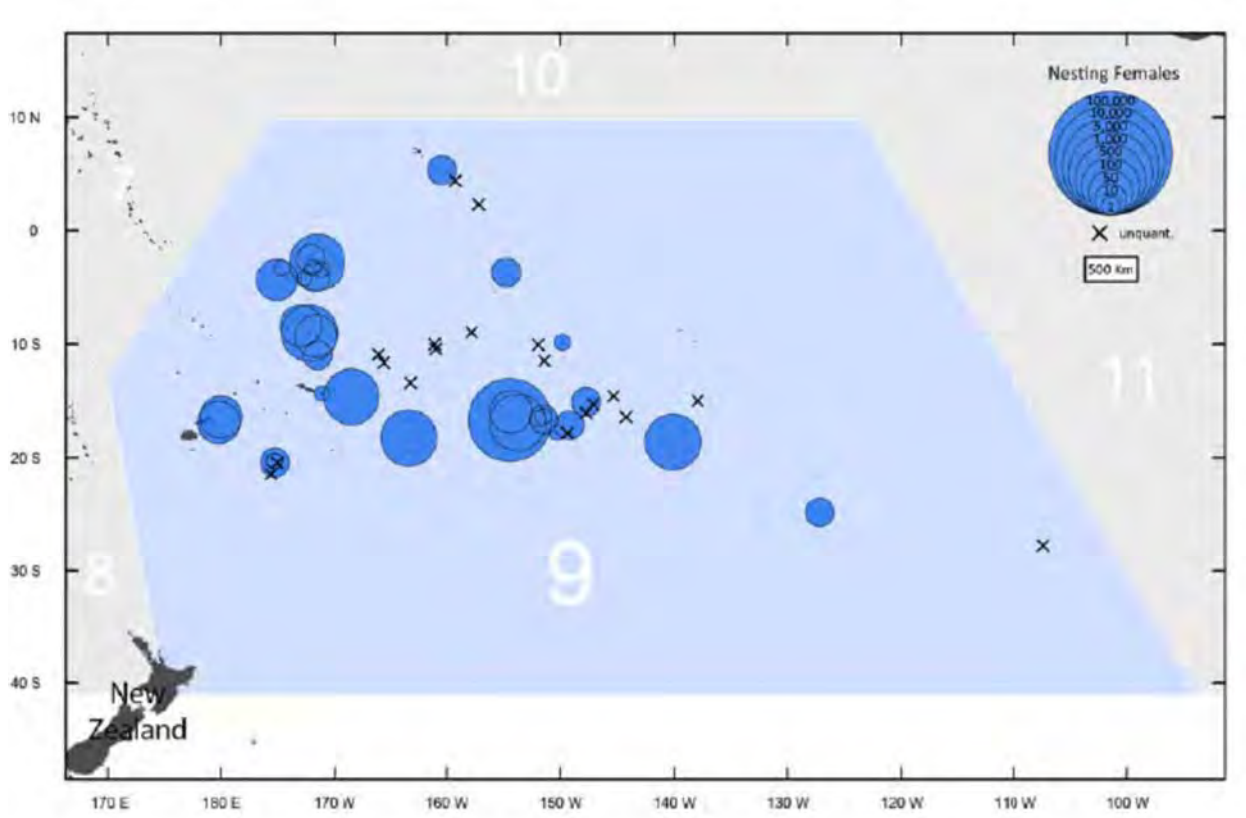

Figure 36. Geographic range of the Central South Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Central South Pacific DPS of green turtles is ESA-listed as endangered.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Nesting abundance information for the Central South Pacific DPS is limited, but is considered to be at low levels and spread out over a large geographic area. There are 59 known nesting sites (22 are unquantified), with an estimated 2,677 nesting females. The largest nesting site is Scilly Atoll in French Polynesia, which hosts 36 percent of the nesting females for the Central South Pacific DPS (Seminoff et al. 2015).

There are no estimates of population growth for the Central South Pacific DPS. The Central South Pacific DPS suffers from a lack of consistent, systematic nesting monitoring, with no nesting site having even five years of continuous data. What data are available indicate steep declines at Scilly Atoll due to illegal harvest, with some smaller nesting sites (e.g., Rose Atoll) showing signs of stability (Seminoff et al. 2015).

There is very limited information available for the Central South Pacific DPS, Mitochondrial DNA studies indicate at least two genetic stocks in the DPS – American Samoa and French Polynesia. Overall, there is a moderate level of diversity for the DPS, and the presence of unique haplotypes (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015).

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

Status

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

Historically, the Central South Pacific DPS declined due to harvest of eggs and females for human consumption or for their shells, a practice that still continues throughout the region. Incidental bycatch in commercial and artisanal fishing gear, lack of regulatory mechanisms, and climate change are significant threats to the long-term viability of the Central South Pacific DPS.

Critical Habitat

No critical habitat has been designated for the Central South Pacific DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Central South Pacific DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.29 Green Turtle – Central West 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 34). The Central West Pacific DPS of green turtle is found in the Pacific Ocean near Papua New Guinea, and West Papua (Figure 37).

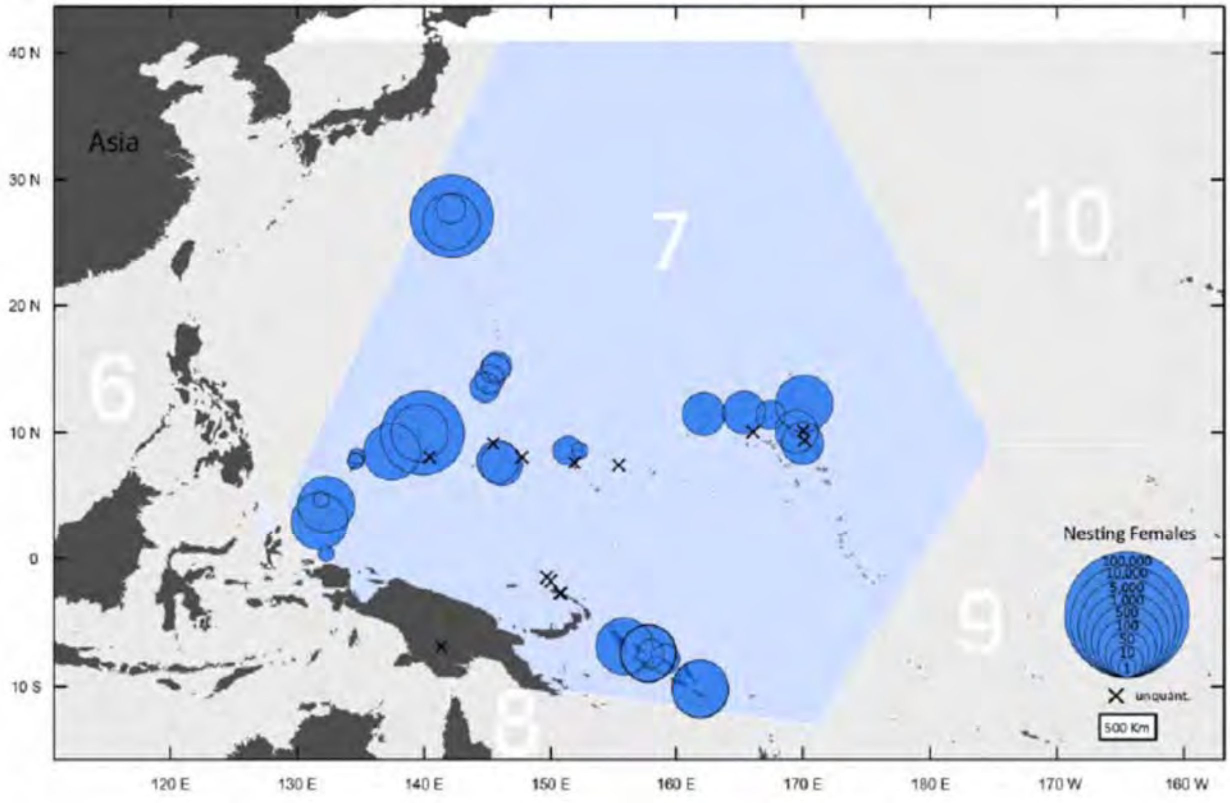

Figure 37. Geographic range of the Central West Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Central West Pacific DPS is ESA-listed as endangered.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). The largest nesting site is in the Federated States of Micronesia, which has 22 percent of the nesting females for the Central West Pacific DPS (Seminoff et al. 2015).

There are no estimates of population growth for the Central West Pacific DPS. Long-term nesting data is lacking for many of the nesting sites in the Central West Pacific DPS, making it difficult to assess population trends. The only site which has long-term data available – Chichijima, Japan – shows a positive trend in population growth (Seminoff et al. 2015).

The Central West Pacific DPS is made up of insular rookeries separated by broad geographic distances. Rookeries that are more than 1,000 km (540 nmi) apart are significantly differentiated, while rookeries 500 km (270 nmi) apart not. Mitochondrial DNA analyses suggest that there are at least seven independent stocks in the region (Dutton et al. 2014).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). The Central West Pacific DPS is composed of nesting assemblages in the Federated States of Micronesia, the Japanese islands of Chichijima and Hahajima, the Marshall Islands, and Palau. Green turtles in the DPS are found throughout the western Pacific Ocean, in Indonesia, the Philippines, the Marshall Islands, and Papua New Guinea.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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.

The Central West Pacific DPS is impacted by incidental bycatch in fishing gear, predation of eggs by ghost crabs and rats, and directed harvest eggs and nesting females for human consumption. Historically, intentional harvest of eggs from nesting beaches was one of the principal causes for decline, and this practice continues today in many locations. The Central West Pacific DPS has a small number of nesting females and a widespread geographic range. These factors, coupled with the threats facing the Central West Pacific DPS and the unknown status of many nesting sites makes the Central West Pacific DPS vulnerable to future perturbations.

Critical Habitat

No critical habitat has been designated for the Central West Pacific DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Central West Pacific DPS green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.30 Green Turtle – East Indian – West 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 34). The East Indian-West Pacific DPS of green turtle is found in the Indian Ocean from Southeast Asia through western Australia (Figure 38).

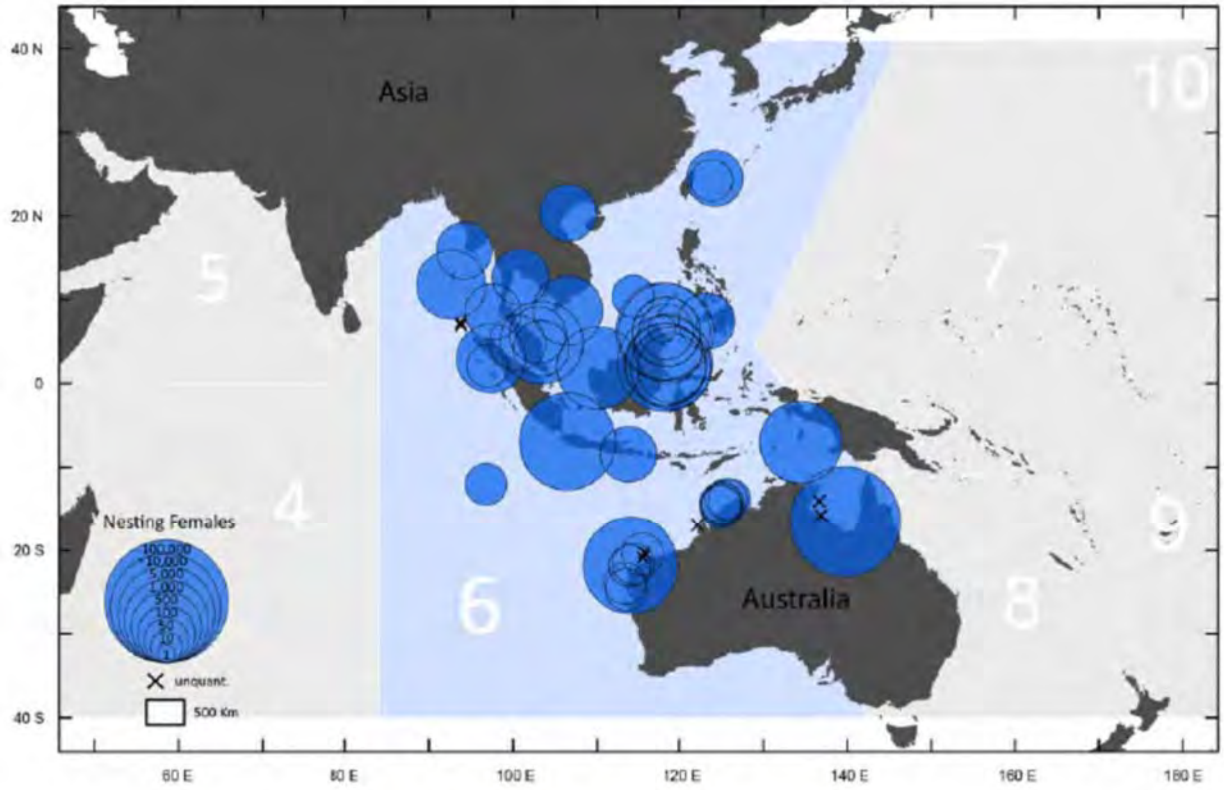

Figure 38: Geographic range of the East Indian-West Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The East Indian-West Pacific DPS is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). There are 58 nesting sites for the East Indian-West Pacific DPS, with a total nester abundance estimated at 77,099. The largest nesting site is the Wellesly Group, three islands in the Gulf of Carpentaria off northern Australia. This group hosts 32 percent of the nesting females for the East Indian-West Pacific DPS (Seminoff et al. 2015).

There are no estimates of population growth for the East Indian-West Pacific DPS. There is variation in the nesting abundance trends across nesting sites, with some showing increase while others are decreasing. Broadly though, there is a decrease in nesting females throughout the DPS with the exception of Malaysia and the Philippines showing an increase, attributed to successful conservation efforts (Seminoff et al. 2015).

Genetic studies have been conducted on over 22 of 58 rookeries in the East Indian-West Pacific DPS, revealing a complex population structure. Sixteen regional genetic stocks have been identified, with a few common and widespread haplotypes throughout the region. Rare or unique haplotypes are present at most rookeries (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). The East Indian-West Pacific DPS comprises nesting sites in Northern Australia, Indonesia, Malaysia, Peninsular Malaysia, and the Philippine Turtle Islands. The East Indian-West Pacific DPS is spread throughout the eastern Indian Ocean, east of Sri Lanka, south to western and northern Australia, Indonesia, Malaysia, and Taiwan, and north to Japan.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 Hz to 800 Hz (Bartol et al. 1999b;

Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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.

The East Indian-West Pacific DPS of green turtle is relatively large, though it has been reduced from historic levels due to overutilization for commercial and subsistence purposes. Green turtles and their eggs are still harvested for consumption in some areas. Other current threats to the East Indian-West Pacific DPS of green turtle include mortality from incidental bycatch, and predation by feral pigs, dogs, and foxes.

Critical Habitat

No critical habitat has been designated for the East Indian-West Pacific DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the East Indian-West Pacific DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.31 Green Turtle – East 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 34). The East Pacific DPS of green turtle is found in the Pacific Ocean from California south to Chile (Figure 39).

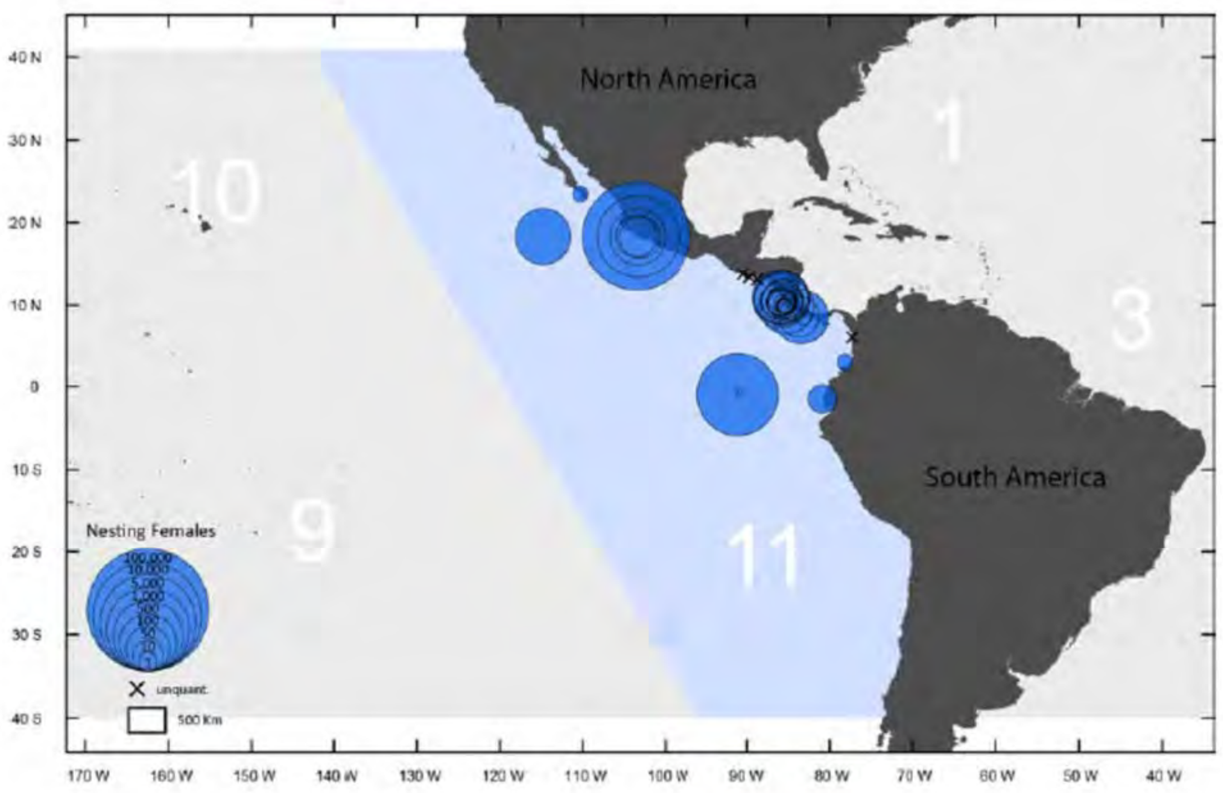

Figure 39. Geographic range of the East Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The East Pacific DPS is ESA-listed as threatened.

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

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 sea 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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). There are 39 nesting sites for the East Pacific DPS, with an estimated at 20,062 nesting females. The largest nesting site is at Colola, Mexico, which hosts 58 percent of the nesting females for the East Pacific DPS (Seminoff et al. 2015).

There are no estimates of population growth for the East Indian-West Pacific DPS. There is variation in the nesting abundance trends across nesting sites, with some showing increase while others are decreasing. Broadly though, there is a decrease in nesting females throughout the DPS with the exception of Malaysia and the Philippines showing an increase, attributed to successful conservation efforts (Seminoff et al. 2015).

Genetic sampling has identified four regional stocks in the East Pacific DPS – Revillagigedos Archipelago, Mexico, Michoacán, Mexico, Central America (Costa Rica), and the Galapagos Islands, Ecuador (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). The East Pacific DPS are found from the California/Oregon border south to central Chile (Figure 39). Major nesting sites occur at Michoacán, Mexico, and the Galapagos Islands, Ecuador. Smaller nesting sites are found on the Pacific Coast of Costa Rica, and in the Revillagigedos Archipelago, Mexico. Scattered nesting occurs in the Colombia, Ecuador, Guatemala, and Peru (Seminoff et al. 2015).

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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.

The population decline for the East Pacific DPS was primarily caused by commercial harvest of green turtles for subsistence and other uses (e.g., sea turtle oil as a cold remedy). Conservation laws are in place in several countries across the range of the East Pacific DPS, but enforcement is inconsistent, limiting effectiveness. Incidental bycatch in commercial fishing, continued harvest, coastal development and beachfront lighting are all continuing threats for the DPS. The observed increases in nesting abundance for the largest nesting aggregation in the region (Michocán, Mexico), a stable trend at Galapagos, and record high numbers at sites in Costa Rica suggest that the population is resilient, particularly in Mexico.

Critical Habitat

No critical habitat has been designated for the East Pacific DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

See the 1998 and 1991 Recovery Plans for the Pacific, East Pacific, and Atlantic populations of green turtles for complete downlisting/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

5.32 Green Turtle – Mediterranean 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 34). The Mediterranean DPS of green turtle is found in the Mediterranean Sea (Figure 40).

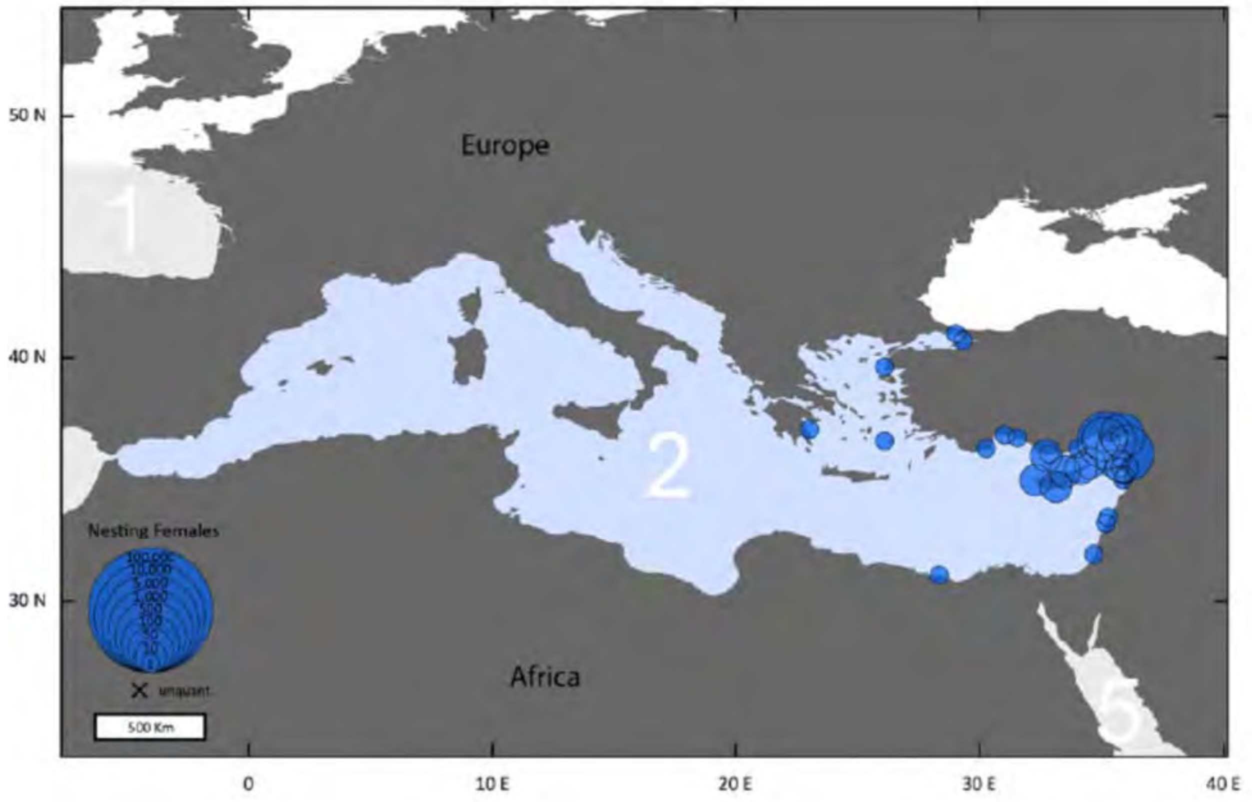

Figure 40: Geographic range of the Mediterranean distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Mediterranean DPS is ESA-listed as endangered.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). There are 32 nesting sites for the Mediterranean DPS, with an estimated 404 to 992 nesting females. The largest nesting site is at Akyatan, Turkey, which comprises 25 percent of the nester abundance for the Mediterranean DPS of green turtle (Seminoff et al. 2015).

There are no estimates of population growth for the Mediterranean DPS as a whole, but trends for some nesting sites can be generally assessed. For sites in Israel, Samandag, Turkey, Akrotiri, Cyprus, and Kazanli, Turkey. With at least ten years of nesting data, increasing trends in nesting abundance area apparent. Other nesting sites in Turkey, Cyprus and Israel show no apparent decreasing trend.

Rookeries in the Mediterranean DPS of green turtle are characterized as having one dominant haplotype. Mitochondrial DNA studies have identified two stocks in the region, one in Cyprus and one in Turkey, but overall population sub-structuring in the Mediterranean in considered low (Seminoff et al. 2015).

The green sea turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles from the Mediterranean DPS have a limited range. Nesting occurs mostly in eastern Mediterranean Sea. Although green turtles disperse throughout the basin, Mediterranean DPS of green turtles have not been found foraging outside the Mediterranean Sea.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). Based upon auditory brainstem responses green sea 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

Status

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

Historically, green turtles in the Mediterranean DPS were subject to harvest, severely depleting the population. The Mediterranean DPS has the lowest nester abundance of any green turtle DPS worldwide. The low nesting abundance, combined with threats like fisheries bycatch and habitat loss from coastal development, threaten the long-term viability of the Mediterranean DPS.

Critical Habitat

No critical habitat has been designated for the Mediterranean DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Mediterranean DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.33 Green Turtle – North Atlantic Distinct Population Segment

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters (Figure 34). The North Atlantic DPS of green turtle is found in the north Atlantic Ocean and Gulf of Mexico (Figure 41).

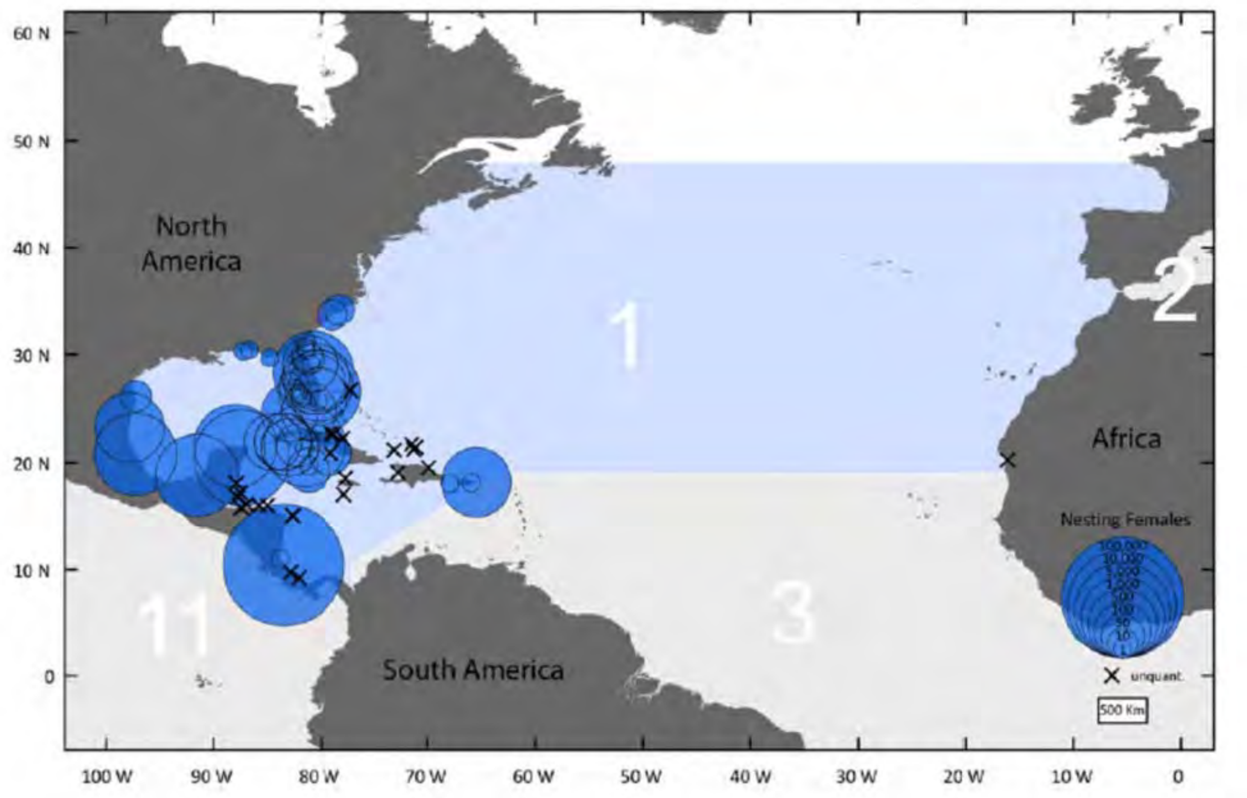

Figure 41. Geographic range of the North Atlantic distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The North Atlantic DPS of green turtle is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites (Figure 41), and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79 percent of nesting females for the DPS (Seminoff et al. 2015).

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

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

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles from the

North Atlantic DPS range from the boundary of South and Central America (7.5° North, 77° West) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48° North, 77° West) in the north. The range of the North Atlantic DPS then extends due east along latitudes 48° North and 19° North to the western coasts of Europe and Africa (Figure 41). Nesting occurs primarily in Costa Rica, Mexico, Florida, and Cuba.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

Status

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

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

Critical Habitat

On September 2, 1998, NMFS designated critical habitat for green turtles, which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, sub-adult, and adult green turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This area provides important developmental habitat for the species. Activities that may affect the critical habitat include beach renourishment, dredge and fill activities, coastal construction, and freshwater discharge. Due to its location, this critical habitat would be accessible by individuals of the North Atlantic DPS.

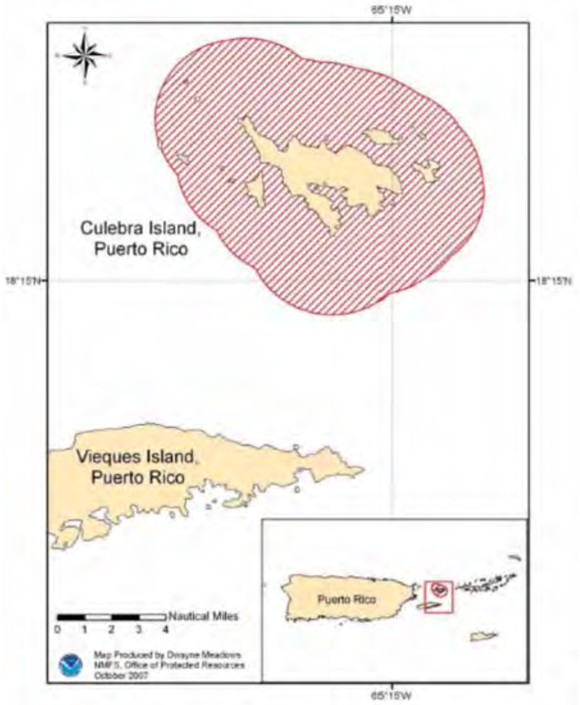

Figure 42: Map of green turtle designated critical habitat in Culebra Island, Puerto Rico.

Recovery Goals

See the 1998 and 1991 recovery plans for the Pacific, East Pacific, and Atlantic populations of green turtles for complete downlisting/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

5.34 Green Turtle – North Indian 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 34). The North Atlantic DPS of green turtle is found in the North Indian Ocean from the east coast of Africa, around the Arabian Peninsula to the west coast of India (Figure 43).

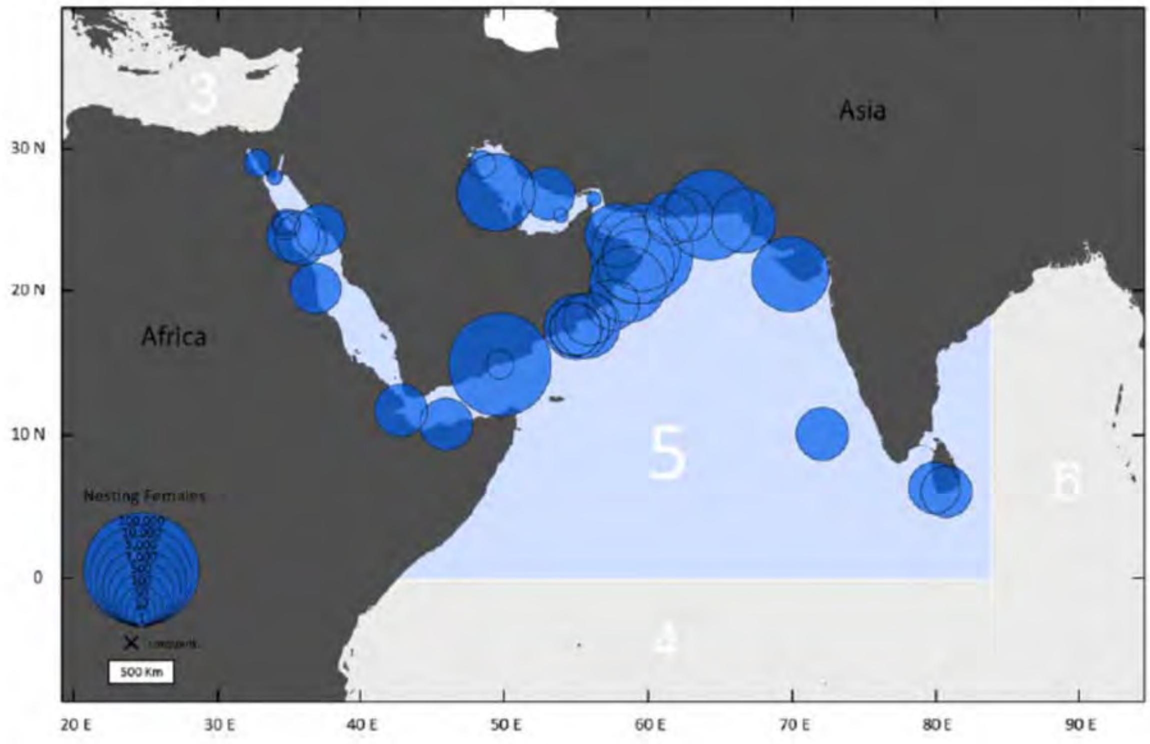

Figure 43. Geographic range of the North Indian distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The North Indian DPS is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Two of the world's largest green turtle nesting sites – in Yemen and Oman – are in the North Indian DPS. There are 38 nesting sites for the North Indian DPS, with a nester abundance estimated at 55,243. The largest nesting site is at Ras Sharma, Yemen, hosting 33 percent of nesting females for the North Indian DPS (Seminoff et al. 2015).

There are no estimates of population growth for the North Indian DPS. Long-term trend data is lacking for all nesting sites in the North Indian DPS, and only nine sites out of 38 have ten or more years of recent data. Even in those cases, there is often a lack of standardization in sampling, making it difficult to understand and ascertain trends. Generally though, nesting sites in Oman represent one of the largest and most important nesting concentrations for green turtles worldwide, with approximately 44,000 nests recorded in 2005, compared to about 6,000 nesting females annually throughout the late 1970s to mid-1980s (Seminoff et al. 2015).

There is little available information on genetic diversity within the North Indian DPS, as mitochondrial DNA studies have only been completed on the Saudi Arabian stock, which was distinct from other rookeries in the Indian Ocean. Population sub-structuring within the DPS is likely, based on the broad spatial distribution of the DPS, but is unconfirmed (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles from the North Indian DPS are found along the eastern coast of Africa from Somalia north to the Red Sea. They are also found in the Gulf of Aden, the Persian Gulf, the Gulf of Oman and along the coast of India to Sri Lanka. Major nesting sites are found on the Arabian Peninsula to the Pakistani-Indian border.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

Status

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

Historically, egg harvest and capture of green turtles for consumption was a cause for the decline of North Indian DPS. The practice is restricted, but still occurs in some regions. Incidental bycatch in fisheries remains a significant threat to the DPS, as do in-water vessel strikes, collisions with beach vehicles during nesting, pollution, and climate change. Conservation laws are in effect, but the effectiveness of these protections vary by country. The large robust nesting beaches in Yemen and Oman contribute to the low risk of extinction for the North Indian DPS.

Critical Habitat

Not critical habitat has been designated for the North Indian DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the North Indian DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.35 Green Turtle – South Atlantic Distinct Population Segment

The green turtle is globally distributed and commonly inhabits nearshore and inshore waters, occurring throughout tropical, sub-tropical and, to a lesser extent, temperate waters (Figure 34). The South Atlantic DPS of green turtle is found in the Atlantic Ocean from South America to the west coast of Africa (Figure 44).

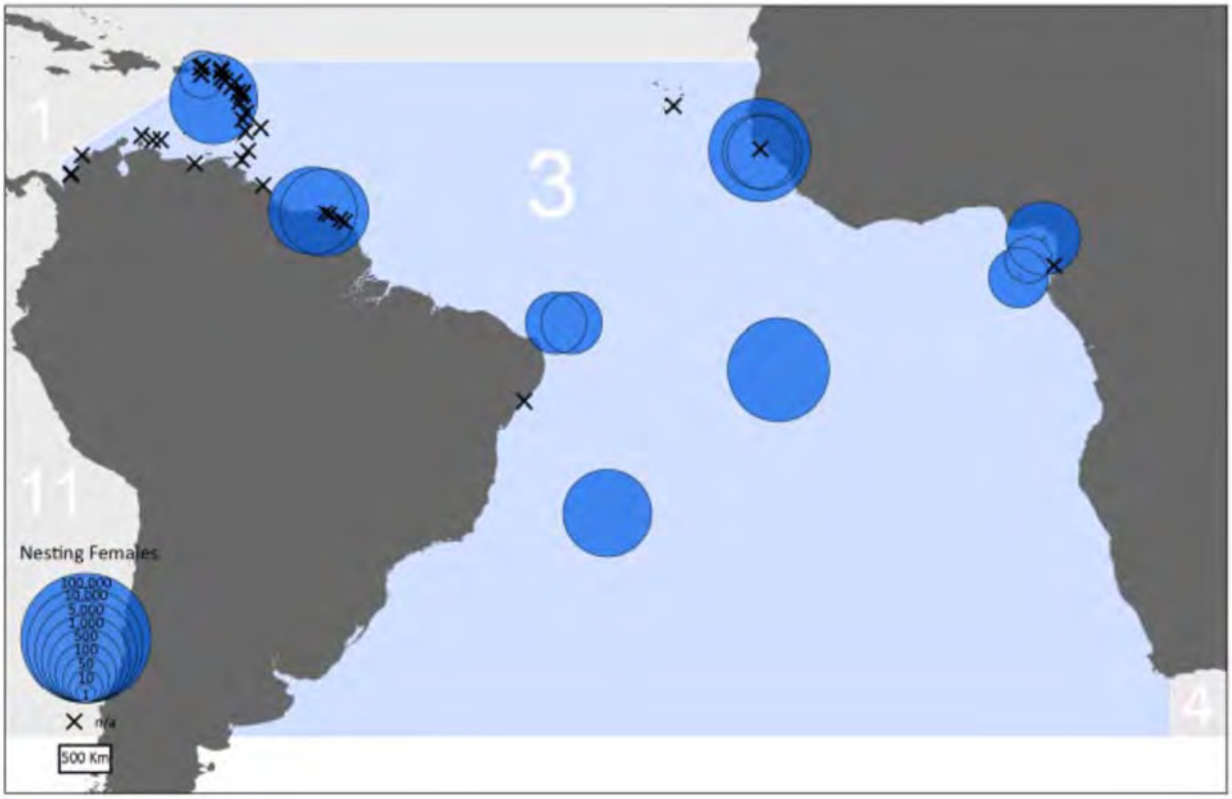

Figure 44. Geographic range of the South Atlantic distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The South Atlantic DPS of green turtle is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). The South Atlantic DPS of green turtle has 51 nesting sites, with an estimated nester abundance of 63,332. The largest nesting site is at Poilão, Guinea-Bissau, which hosts 46 percent of nesting females for the South Atlantic DPS of green turtle (Seminoff et al. 2015).

There are 51 nesting sites for the South Atlantic DPS of green turtle, and many have insufficient data to determine population growth rates or trends. Of the nesting sites where data are available, such as Ascension Island, Suriname, Brazil, Venezuela, Equatorial Guinea, and Guinea-Bissau, there is evidence that population abundance is increasing (Seminoff et al. 2015).

Individuals from nesting sites in Brazil, Ascension Island, and western Africa have a shared haplotype found in high frequencies. Green turtles from rookeries in the eastern Caribbean Sea, however, are dominated by a different haplotype (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Nesting for the South Atlantic DPS of green turtle occurs on both sides of the Atlantic Ocean, along the western coast of Africa, Ascension Island, the U.S. Virgin Islands in the Caribbean Sea and eastern South

America, from Brazil north to the Caribbean Sea. Juveniles and adults can be found on feeding grounds in the Caribbean and the nearshore waters of Brazil, Uruguay, and Argentina. In the east, South Atlantic DPS of green turtles can be found on foraging grounds off the coast of west Africa, from Equatorial Guinea, Gabon, Congo, Angola, and Principe Island.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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.

Though there is some evidence that the South Atlantic DPS of green turtle is increasing, there is considerable amount of uncertainty over the impacts of threats to the South Atlantic DPS. The

DPS is threatened by habitat degradation at nesting beaches, and mortality from fisheries bycatch remains a primary concern.

Critical Habitat

No critical habitat has been designated for the South Atlantic DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the South Atlantic DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.36 Green Turtle – Southwest Indian 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 34). The Southwest Indian DPS of green turtle is found in the Indian Ocean near the east coast of Africa (Figure 45).

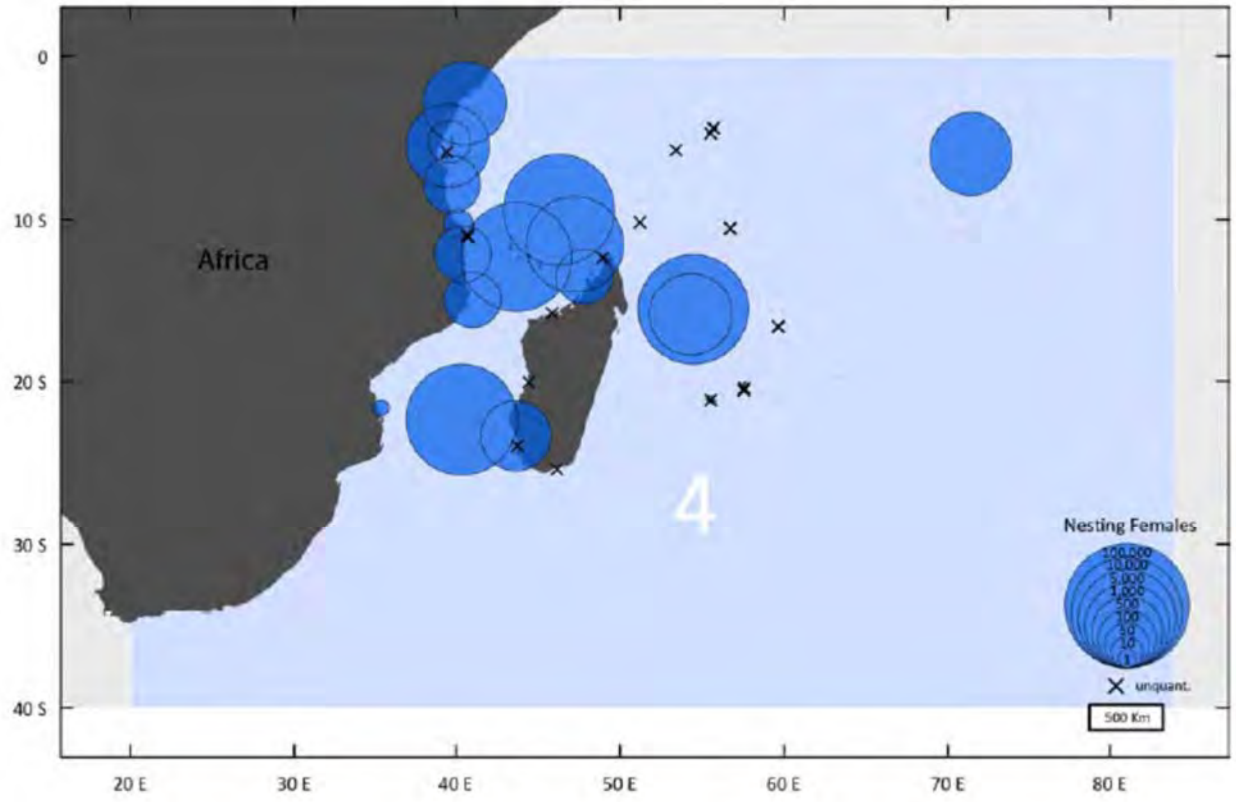

Figure 45: Geographic range of the Southwest Indian distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Southwest Indian DPS of green turtle is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). There are 37 nesting sites for the Southwest Indian DPS, with an estimated nester abundance of 91,059. The largest nesting site is on Europa, Eparses Island, a small atoll in the Mozambique Channel, which hosts 30 percent of nesting females for the Southwest Indian DPS of green turtle (Seminoff et al. 2015).

Trend data is lacking for a number of nesting sites in the Southwest Indian DPS of green turtle, and it is not possible to determine the population growth rate for the DPS. At several protected nesting sites with long-term data available, nesting is stable or shows signs of increase. At Glorieuses, Europa, and Mayotte, all within the French Eparses Islands, annual growth rates have been 3.5, 2.0, and 0.9 percent, respectively. Other sites within the DPS such as the Comoros Islands and the Seychelles show increasing trends, although growth rates cannot be calculated.

Genetic studies of green turtles in the Southwest Indian DPS identified seven haplotypes and a mix of common and widespread haplotypes, indicating high genetic diversity. Despite gaps in genetic sampling of the northern rookeries, there is a moderate degree of spatial structuring within the Southwest Indian DPS, with at least two genetic stocks: the South Mozambique Channel, and the North Mozambique Channel (Seminoff et al. 2015).

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). Green turtles from the Southwest Indian DPS is comprised of individuals in Madagascar, eastern Africa from Kenya to South Africa, and island nations in the western Indian Ocean. Major nesting beaches for the Southwest Indian DPS are found in the French Eparses Islands, Mayotte, and the outer Seychelles Islands.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

Status

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

Historically, green turtles in the Southwest Indian DPS were subject to harvest, severely depleting the population. The Southwest Indian DPS is currently threatened by incidental capture in fisheries and by climate change, as sea level rise could eliminate nesting habitat on many low-lying atolls in the region. Conservation measures have been put in place by several countries establishing protected nesting areas and monitoring programs, which are believed to be contributing to the increasing population trends. The Southwest Indian DPS is considered to have a low risk of extinction in the next 100 years, and has shown itself to be resilient to past harvest.

Critical Habitat

No critical habitat has been designated for the Southwest Indian DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southwest Indian DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.37 Green Turtle – Southwest 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 34). The Southwest Pacific DPS of green turtle is found in the Pacific Ocean near eastern Australia and northern New Zealand (Figure 46).

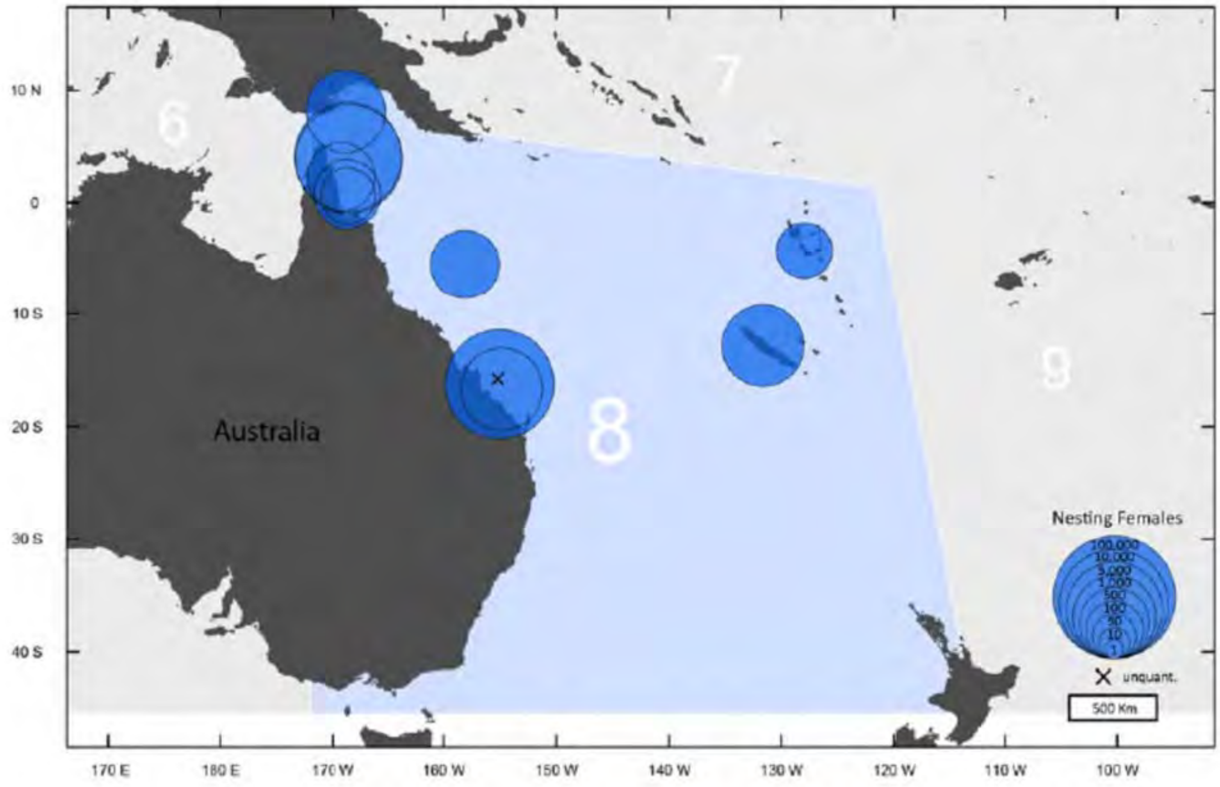

Figure 46. Geographic range of the Southwest Pacific distinct population segment of green turtle, with location and abundance of nesting females (Seminoff et al. 2015).

The green turtle is the largest of the hardshell sea turtles, growing to a weight of 158.8 kg (350 lb) 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 (Table 46). The Southwest Pacific DPS is ESA-listed as threatened.

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

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.

Population Dynamics

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

The green turtle occupies the coastal waters of over 140 countries worldwide; nesting occurs in more than 80 countries. Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Nesting sites for the Southwest Pacific DPS are widely distributed throughout the region. With proximate nesting sites grouped, there are 12 nesting sites in the Southwest Pacific DPS, with an estimated 83,058 nesting females. The largest nesting site is at the northern Great Barrier Reef, Australia, which hosts 38 percent of the nesting females for the Southwest Pacific DPS of green turtle (Seminoff et al. 2015).

There are no estimates of population growth rates for the Southwest Pacific DPS. Only two nesting sites in the Southwest Pacific DPS have more than 15 years of data – Raine Island and Heron Island, both in the northern Great Barrier Reef. Both sites show a slight increasing trend (Seminoff et al. 2015).

Of the sampled rookeries in the Southwest Pacific DPS, genetic testing shows significant population sub-structuring. Four regional genetic stocks have been identified (Dethmers et al.

2006; Jensen 2010). The Southwest Pacific DPS is characterized as having high genetic diversity due to a variety of highly divergent lines found at nesting sites.

The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, sub-tropical and, to a lesser extent, temperate waters (Seminoff et al. 2015). The Southwest Pacific DPS extends off the eastern coast of Australia, south of Papua New Guinea, and goes east to encompass Vanuata and New Caledonia. Major nesting sites for the DPS include the Great Barrier Reef, eastern Torres Strait, and the northern Great Barrier Reef. Nesting also occurs in New Caledonia, Vanuata, and the Coral Sea Islands.

Many nesting sites worldwide suffer from a lack of consistent, standardized monitoring, making it difficult to characterize population growth rates for a DPS.

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 Hz to 800 Hz (Bartol et al. 1999b; Lenhardt 1994; 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 1994). 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 et al. 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 et al. 1999b). 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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 turtle populations in the Southwest Pacific DPS declined due to intense harvest in the last century. The Southwest Pacific DPS is currently under threat from incidental bycatch in fishing gear, although conservation programs in Australia, New Caledonia, and Vanuatu are in place to mitigate the impacts. Although the directed commercial harvest of eggs and nesting females is prohibited in Australia, harvest occurs in the neighboring countries of Fiji, New Caledonia, Papua New Guinea, and Indonesia. Boat strike, bycatch in shark control programs, increases in sea surface temperatures due to climate change all threaten the Southwest Pacific DPS. Populations at the two largest nesting beaches in the Southwest Pacific DPS are stable or increasing, but uncertainty about population trends in other parts of the DPS still warrant concern.

Critical Habitat

Not critical habitat has been designated for the Southwest Pacific DPS of green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southwest Pacific DPS of green turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.38 Hawksbill Turtle

The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, sub-tropical oceans (Figure 47).

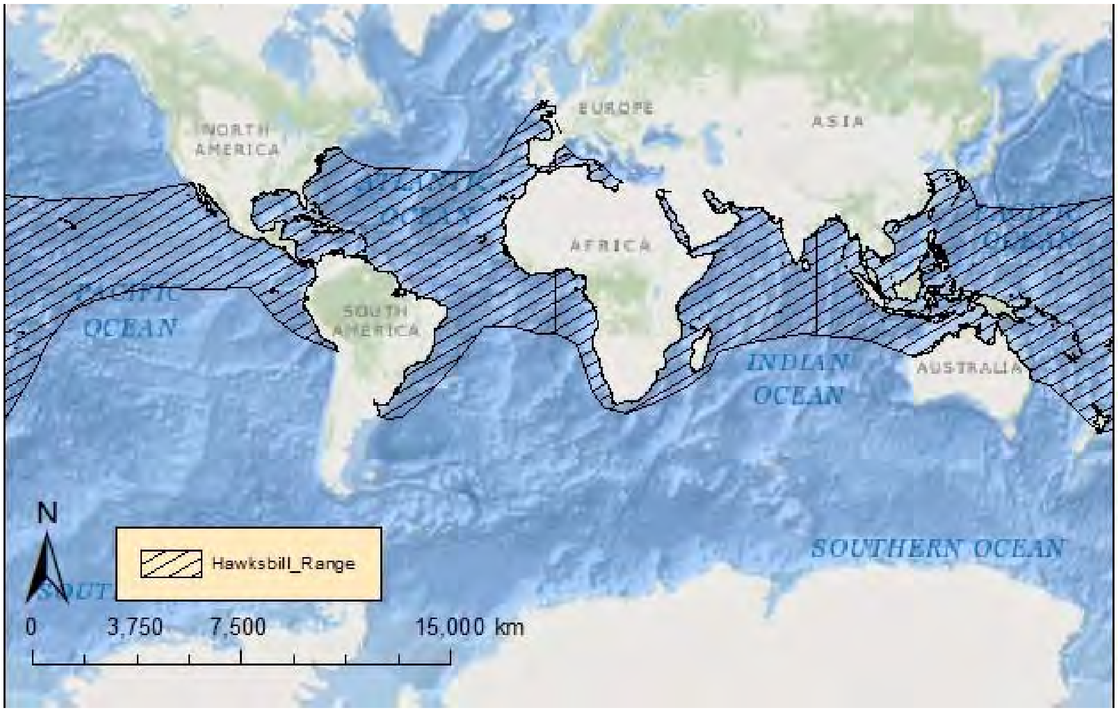

Figure 47. Map identifying the range of the endangered hawksbill turtle.

The hawksbill turtle has a sharp, curved, beak-like mouth and a “tortoiseshell” 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 (Table 46). We used information available in the five year reviews (NMFS 2013b; NMFS and USFWS 2007a) to summarize the life history, population dynamics and status of the species, as follows.

Life History

Hawksbill turtles reach sexual maturity at twenty to forty 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 twenty two to twenty five centimeters in straight carapace length. As juveniles, they take up residency in coastal waters to forage and grow. As adults, hawksbills 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).

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.

From 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehaujes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (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 et al. 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 et al. 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).

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 et al. 1999b; Lenhardt 1994; 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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 or 4 kHz (Patterson 1966)

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.

Critical Habitat

On September 2, 1998, NMFS established critical habitat for hawksbill turtles around Mona and Monito Islands, Puerto Rico (Figure 48). Aspects of these areas that are important for hawksbill turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill turtle prey.

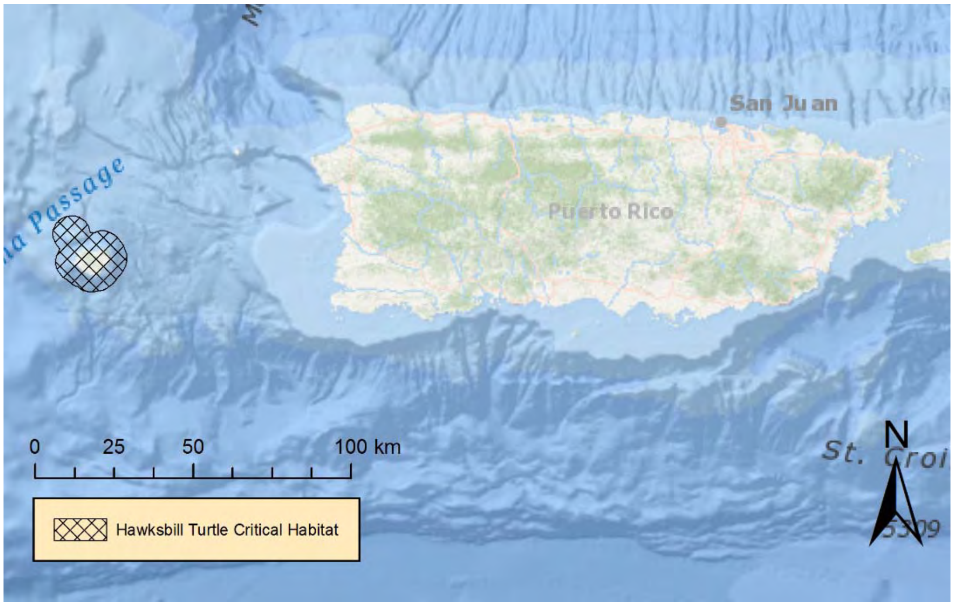

Figure 48. Map depicting hawksbill turtle designated critical habitat.

Recovery Goals

See the 1992 and 1998 Recovery Plans for the U.S. Caribbean, Atlantic, and Gulf of Mexico and U.S. Pacific populations of hawksbill turtles, respectively, for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were the top recovery actions identified to support in the Recovery Plans:

1. Identify important nesting beaches.
2. Ensure long-term protection and management of important nesting beaches.

3. Protect and manage nesting habitat; prevent the degradation of nesting habitat caused by seawalls, revetments, sand bags, other erosion-control measures, jetties, and breakwaters.
4. Identify important marine habitats; protect and manage populations in marine habitat.
5. Protect and manage marine habitat; prevent the degradation or destruction of important (marine) habitats caused by upland and coastal erosion.
6. Prevent the degradation of reef habitat caused by sewage and other pollutants.
7. Monitor nesting activity on important nesting beaches with standardized index surveys.
8. Evaluate nest success and implement appropriate nest-protection on important nesting beaches.
9. Ensure that law-enforcement activities prevent the illegal exploitation and harassment of sea turtles and increase law-enforcement efforts to reduce illegal exploitation.
10. Determine nesting beach origins for juveniles and sub-adult populations.

5.39 Kemp's Ridley Turtle

The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas (Figure 49).

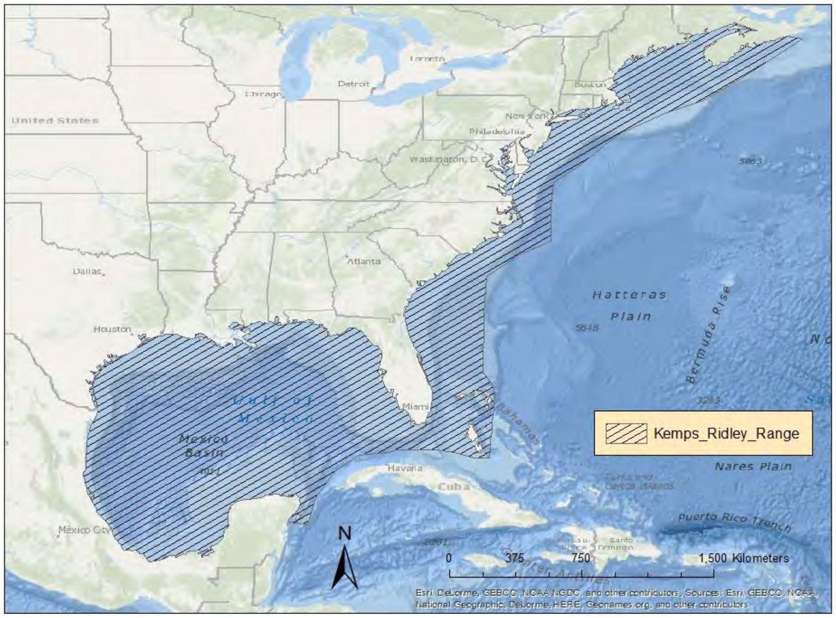

Figure 49. Map identifying the range of the endangered Kemp's ridley turtle.

Kemp's ridley turtles the smallest of all sea turtle species, with nearly circular top shell and a pale yellowish bottom shell. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973 (Table 46).

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

Life History

Females mature at 12 years of age. The average remigration is two years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is 97 to 100 eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats. Juvenile Kemp's ridley turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 37 m (120 ft) deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridley turtles forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS 2011a).

Population Dynamics

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

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

From 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS 2015d).

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

The Kemp's ridley turtle occurs from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). Kemp's ridley turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. During spring and summer, juvenile Kemp's ridley turtles occur in the shallow coastal waters of the northern Gulf of Mexico from Texas to north Florida.

In the fall, most Kemp's ridley turtles migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many sea turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010).

Vocalization and Hearing

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

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

Status

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

Critical Habitat

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

Recovery Goals

See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp's ridley turtles for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were identified as priorities to recover Kemp's ridley turtles:

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

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

5.40 Leatherback Turtle

The leatherback turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to sub-polar latitudes, worldwide (Figure 50).

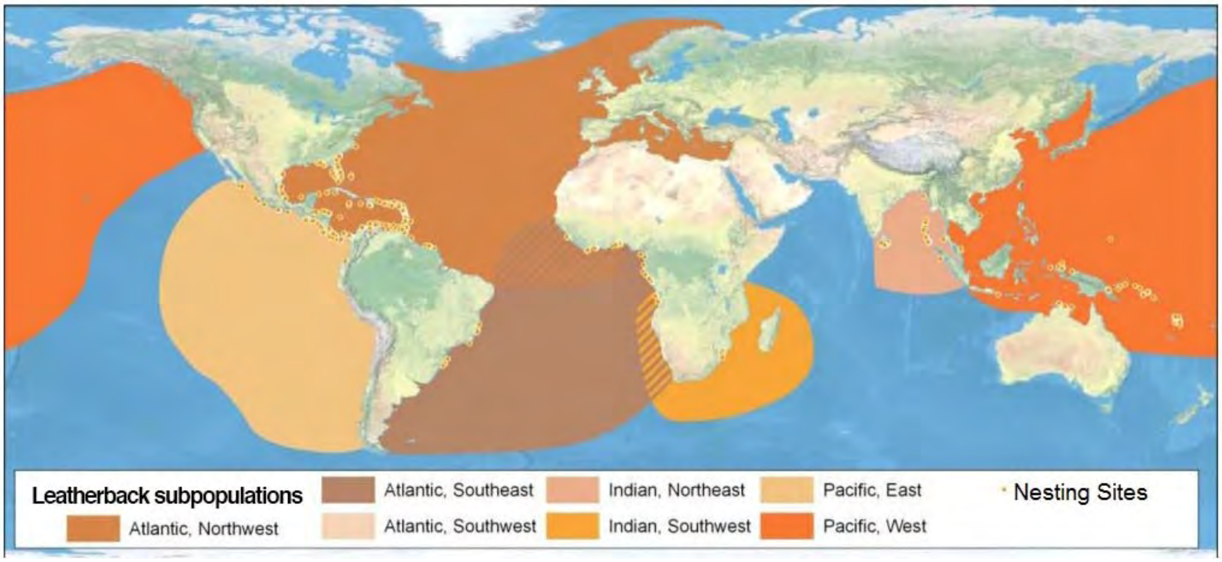

Figure 50. Map identifying the range of endangered leatherback turtle (adapted from (Wallace et al. 2013)).

Leatherback turtles are the largest living sea turtle, reaching lengths of 1.8 m (6 ft) long, and weighing up to 907.2 kg (2,000 lb). Leatherback turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their belly. The species was first listed under the Endangered Species Conservation Act and listed as endangered under the ESA since 1973 (Table 46).

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

Life History

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

Population Dynamics

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

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

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

Analyses of mitochondrial DNA from leatherback turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian Oceans suggest that each of the rookeries represent demographically independent populations (NMFS 2013c).

Leatherback turtles are distributed in oceans throughout the world (Figure 50). Leatherback turtles occur through marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). To date, only one study has investigated hearing of the leatherback turtle (Piniak 2012). Piniak (2012) measured hearing of hatchlings in water an in air, and observed reactions to low frequency sounds, with responses to stimuli occurring between 50 Hz and 1.6 kHz in air between 50 Hz and 1.2 kHz in water (lowest sensitivity recorded was 93 dB re: 1 µPa at 300 Hz).

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

Status

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

Critical Habitat

On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands from the 183 m (600 ft) isobath to mean high tide level between 17° 42’ 12” North and 65° 50’ 00” West (Figure 51). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. The designated critical habitat is within the Sandy Point National Wildlife Refuge. Leatherback turtle nesting increased at an annual rate of thirteen percent from 1994 to 2001; this rate has slowed according to nesting data from 2001 to 2010 (NMFS 2013c).

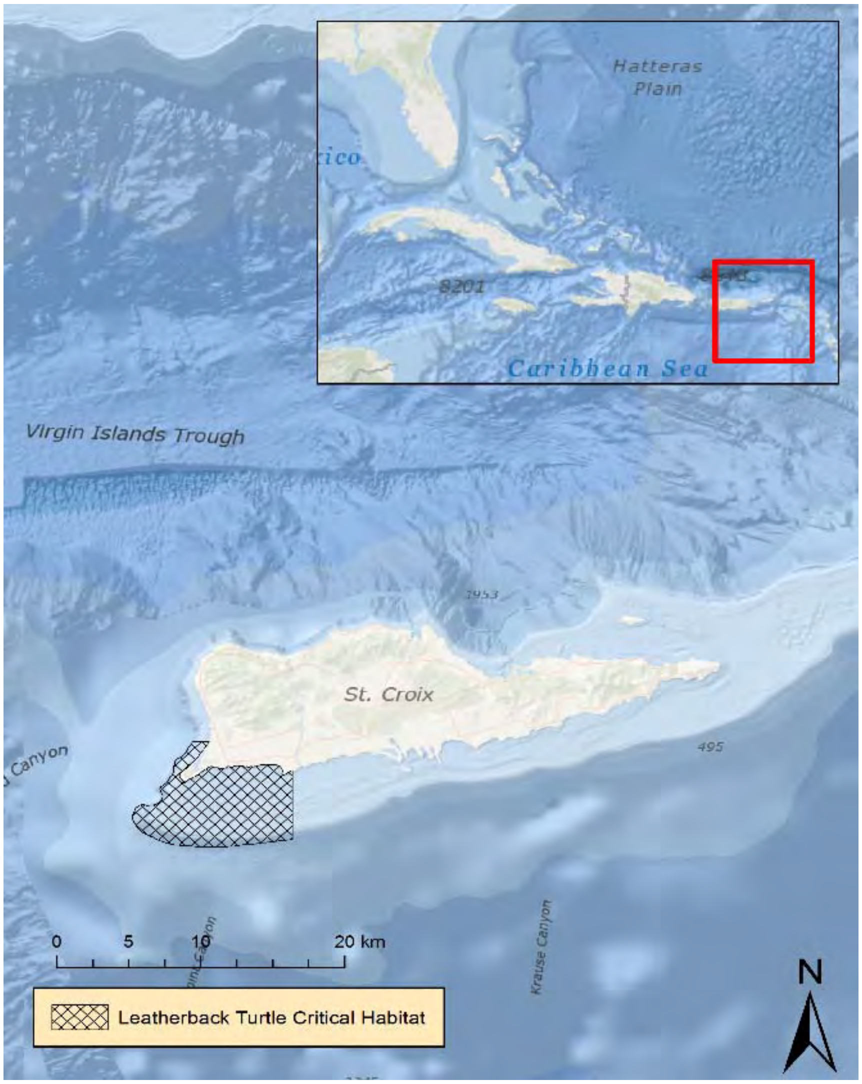

Figure 51. Map depicting leatherback turtle designated critical habitat in the United States Virgin Islands.

On January 20, 2012, NMFS issued a final rule to designate additional critical habitat for the leatherback turtle (50 CFR §226). This designation includes approximately 43,798 km^2 (12,769 nmi^2) stretching along the California coast from Point Arena to Point Arguello east of the 3,000 m (9,842 ft) depth contour; and 64,760 km^2 (18,881 nmi^2) stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 m (6,562 ft) depth contour (Figure 52). The designated areas comprise approximately 108,558 km^2 (31,650 nmi^2) of marine habitat and include waters from the ocean surface down to a maximum depth of 80 m (262 ft). They were designated specifically because of the occurrence of prey species, primarily *scyphomedusae* of the order *Semaeostomeae* (i.e., jellyfish), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

Figure 52. Map depicting leatherback turtle designated critical habitat along the United States Pacific Coast.

Recovery Goals

See the 1998 and 1991 Recovery Plans for the U.S. Pacific and U.S. Caribbean, Gulf of Mexico, and Atlantic leatherback turtles for complete downlisting/delisting criteria for each of their respective recovery goals. The following items were the top five recovery actions identified to support in the Leatherback Five Year Action Plan:

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

5. Public engagement.

5.41 Loggerhead Turtle – Mediterranean Sea Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). Mediterranean Sea DPS loggerhead turtles are found in the Mediterranean Sea, from the Strait of Gibraltar to Turkey (Figure 54).

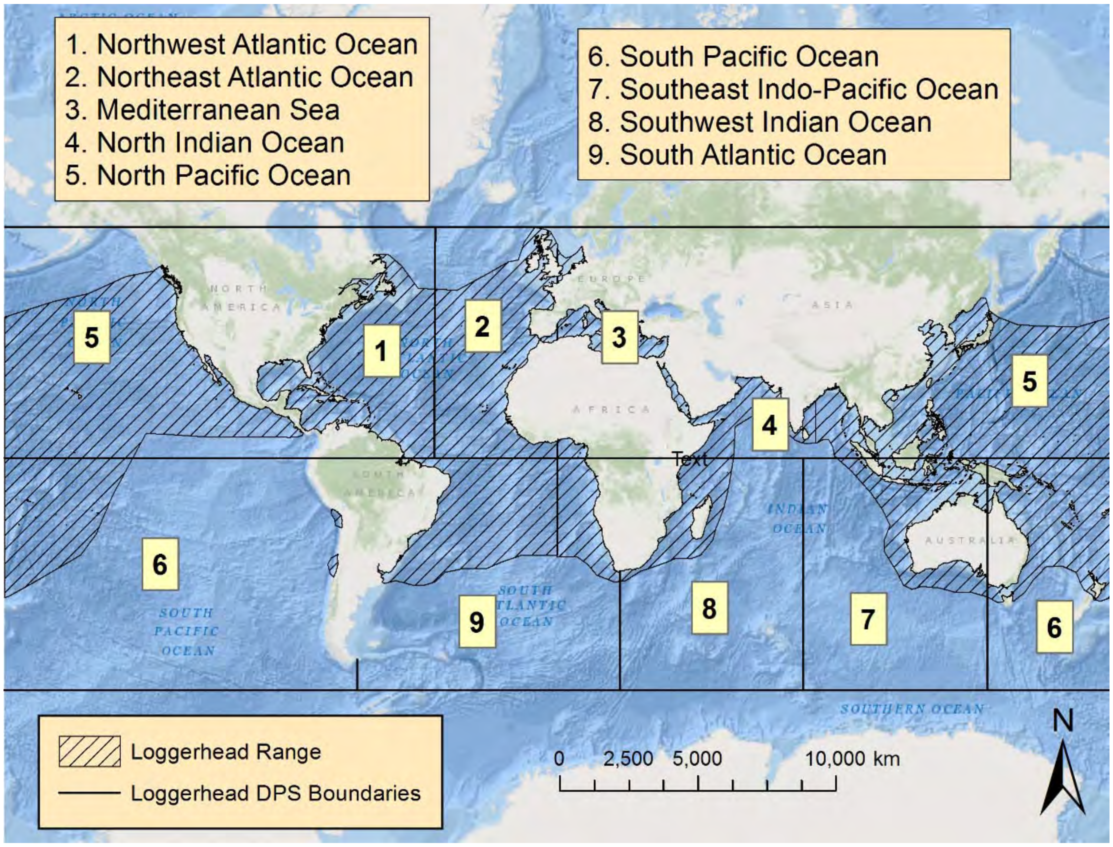

Figure 53. Map identifying the range and distinct population segment boundaries of the loggerhead turtle.

Figure 54. Map identifying the range of the Mediterranean Sea distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Mediterranean Sea DPS of loggerhead turtle listed as endangered (Table 46).

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.

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.

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 Mediterranean Sea DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Based on average number of documented nests in 2010, there are over 7,200 loggerhead turtle nests a year in the Mediterranean Sea, although some sites are showing a decline in the number of nests (Otero and Conigliaro 2012). Nesting in the Mediterranean Sea is confined almost exclusively to the eastern basin, with major nesting sites occurring in Cyprus, Turkey, and Greece (Margaritoulis and Rees 2003). There are lesser nesting sites located in Libya, Egypt, Lebanon, Syria, southern Italy, Israel, and Tunisia (Conant et al. 2009). The highest level of nesting in the Mediterranean Sea occurs in Greece, with an average of 3,050 nests per year (Margaritoulis et al. 2003); a total of 2,280 to 2,787 loggerhead turtles are thought to nest in Cyprus annually (Broderick et al. 2002).

There was not sufficient time series nesting data to calculate population growth rates for the Mediterranean Sea DPS in the 2009 status review (Conant et al. 2009). Annual nest numbers at some sites are in decline (Otero and Conigliaro 2012), such as at two significant nesting sites in Crete, with declines of about six percent annually (Margaritoulis et al. 2009; Margaritoulis et al. 2010).

The Mediterranean Sea DPS of loggerhead turtle is genetically distinct, and testing performed on mitochondrial DNA indicates that there are four independent sub-populations based on different nesting groups within the Mediterranean Sea: (1) Mainland Greece and adjoining Ionian Islands, (2) eastern Turkey, (3) Israel, and (4) Cyprus (Conant et al. 2009). More recent analyses of longer sequences of mitochondrial DNA (800 base pairs versus 380) reveals seven genetically distinct rookery clusters in the Mediterranean: Calabria, Italy, Libya, western Greece, Crete, Dalyan and Dalaman, Turkey, western Turkey, and remaining eastern basin rookeries (e.g., Israel and Lebanon) (Shamblin 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.

Loggerhead turtle hatchlings disperse throughout the Mediterranean Sea, with the location of their natal nesting beach influencing where they disperse. Hatchlings from the Levantine Basin (i.e., the eastern Mediterranean) and south-central Mediterranean tended to stay in that region, and similarly, hatchlings from the Ionian Sea dispersed through the Ionian and Adriatic Seas (Casale and Mariani 2014). Adults and juvenile loggerhead turtles in the Mediterranean Sea show a tendency to disperse widely, traveling from the Ionian Sea to the Adriatic and Aegean Seas, and some from Turkey to the Aegean Sea (Bentivegna et al. 2007; Casale et al. 2007; Margaritoulis and Teneketzis 2003). Juvenile loggerhead turtles from the Mediterranean Sea DPS are rare in the Atlantic, but individuals from Greece and Turkey can be found in feeding aggregations off to Brazil, Panama, Nicaragua, Gulf of Mexico, southern Atlantic coast of Florida, northern coast of Florida and North Carolina, the Azores, and Canary Islands (Masuda 2010).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 μPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

The potential for future decline for the Mediterranean Sea DPS of loggerhead turtle is considered high, according to the NMFS Loggerhead Biological Review Team due to threats from fisheries interactions, pollution, vessel collisions, and habitat destruction of nesting beaches. Neritic and oceanic juveniles and adults are thought to be most vulnerable (Conant et al. 2009).

Critical Habitat

No critical habitat has been designated for the Mediterranean Sea DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Mediterranean Sea DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.42 Loggerhead Turtle – North Indian Ocean Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). North Indian Ocean DPS of loggerhead turtles are found in the northern Indian Ocean, along the east coast of Africa, the coasts of Yemen, Oman, Iran, Pakistan, India, and Southeast Asia (Figure 55).

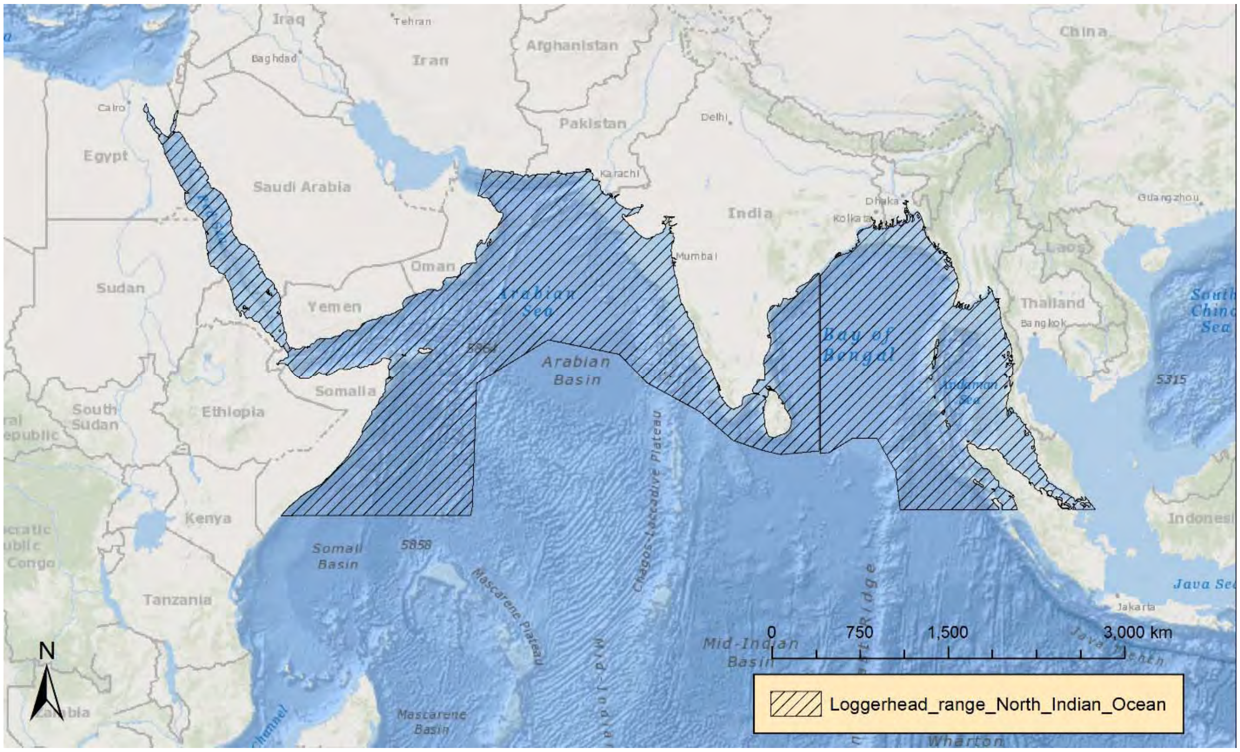

Figure 55. Map identifying the range of the North Indian Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the North Indian Ocean DPS listed as endangered (Table 46).

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.

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.

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 Indian Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Masirah Island in Oman is one of the largest loggerhead turtle nesting sites in the world, with an estimated 20,000 to 40,000 females nesting annually (Baldwin et al. 2003). Al-Halaiyat Island, also in Oman, supports about 3,000 nests annually (Salm 1991). The Arabian Sea coast of Oman is thought to host about 2,000 loggerhead nests every year (Salm et al. 1993). Sri Lanka hosts a small number of nesting females each year, but there is no evidence that the island was ever a major nesting area (Dodd Jr. 1988; Kapurusinghe 2006). In Yemen, between 50 and 100 females nest on the island of Socotra (Pilcher and Saad 2000). There are some accounts of loggerhead turtles nesting in Myanmar, but these reports are not considered reliable because the loggerhead turtles might be misidentified as olive ridley turtles (Thorbjarnarson et al. 2000).

There was not sufficient time series nesting data to calculate population growth rates for the North Indian Ocean DPS in the 2009 status review (Conant et al. 2009). All loggerhead turtles from Oman express a unique haplotype not found in Atlantic rookeries (Shamblin 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. The Masirah Island, Oman, haplotype was present in foraging aggregations in the South Atlantic Ocean, indicating that loggerhead turtles from the North Indian Ocean DPS may use major surface currents to migrate to a different ocean basin to forage (Shamblin et al. 2014).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

Although there is no nesting beach data available for the North Indian Ocean DPS of loggerhead turtle, the threat matrix indicates a likely decline in the population in the foreseeable future. This predicted decline is driven by mortality in commercial and artisanal fisheries and threats to nesting beaches (Conant et al. 2009).

Critical Habitat

No critical habitat has been designated for the North Indian Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the North Indian Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.43 Loggerhead 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 (Figure 53). 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 56).

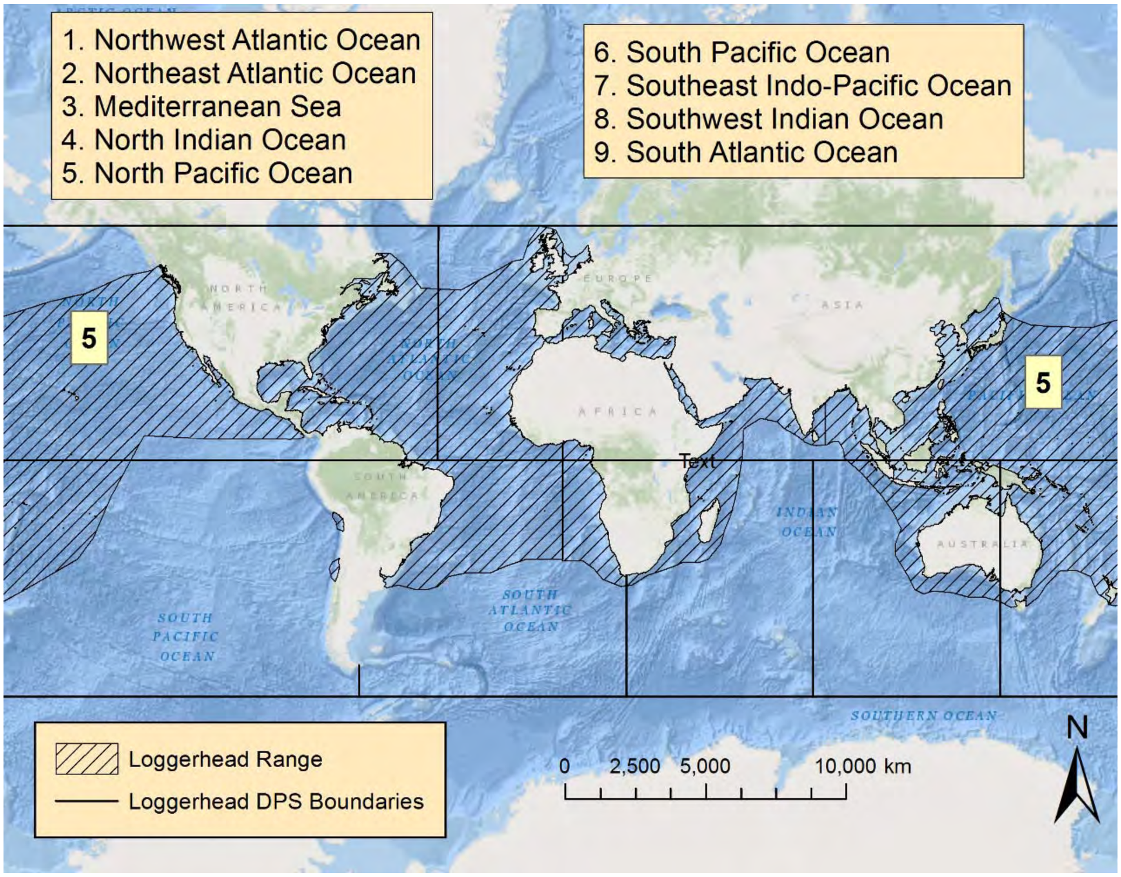

Figure 56. Map identifying the range of the North Pacific Ocean distinct population segment loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the North Pacific Ocean DPS listed as endangered (Table 46).

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.

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.

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 Indian Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

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 et al. 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 et al. 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 Kurishio 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 (Abecassis et al. 2013; Seminoff et al. 2014).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

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).

Critical Habitat

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

Recovery Goals

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

5.44 Loggerhead Turtle – Northeast Atlantic Ocean Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). Northeast Atlantic Ocean DPS of loggerhead turtles are found in the northeastern Atlantic Ocean, from Western Europe to western Africa (Figure 57).

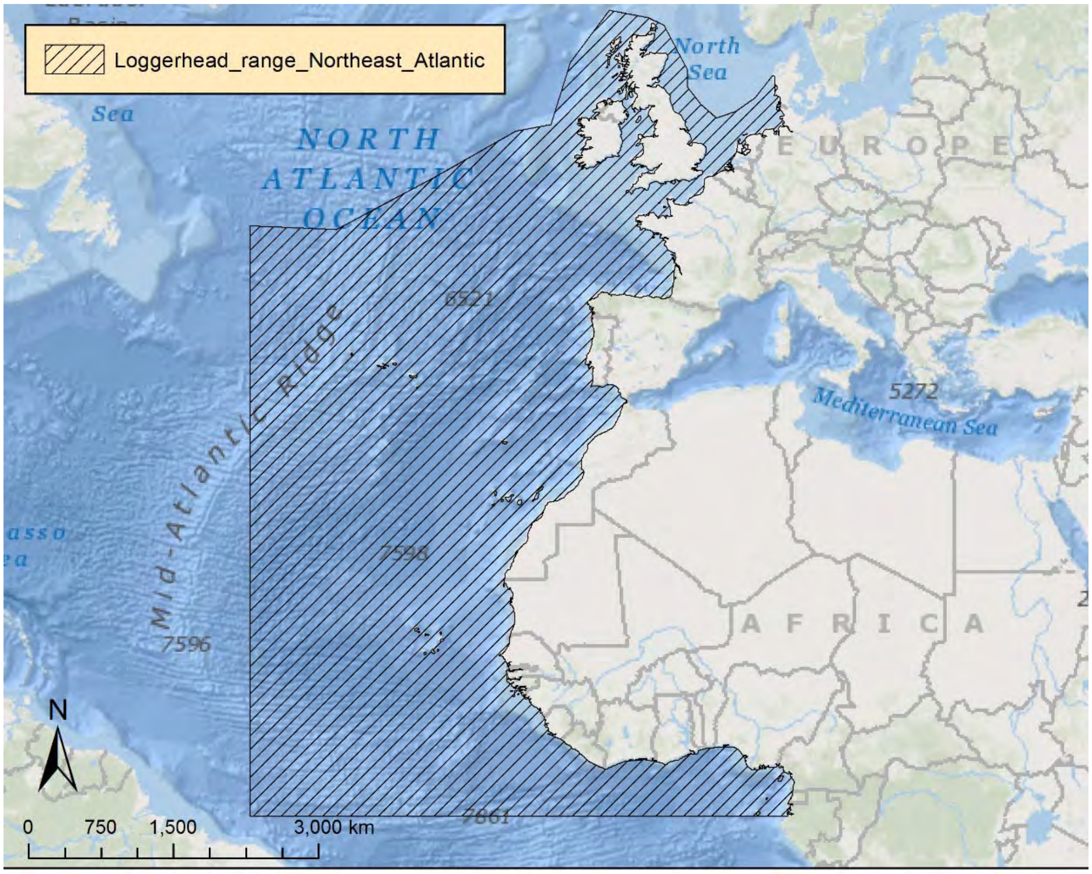

Figure 57. Map identifying the range of the Northeast Atlantic Ocean distinct population segment loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Northeast Atlantic Ocean DPS of loggerhead turtle listed as endangered (Table 46).

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.

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.

Population Dynamics

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

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

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

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

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

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

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

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

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

Critical Habitat

No critical habitat has been designated for the Northeast Atlantic Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Northeast Atlantic Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.45 Loggerhead Turtle – Northwest Atlantic Ocean Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). Northwest Atlantic Ocean DPS of loggerhead turtles are found along eastern North America, Central America, and northern South America (Figure 58).

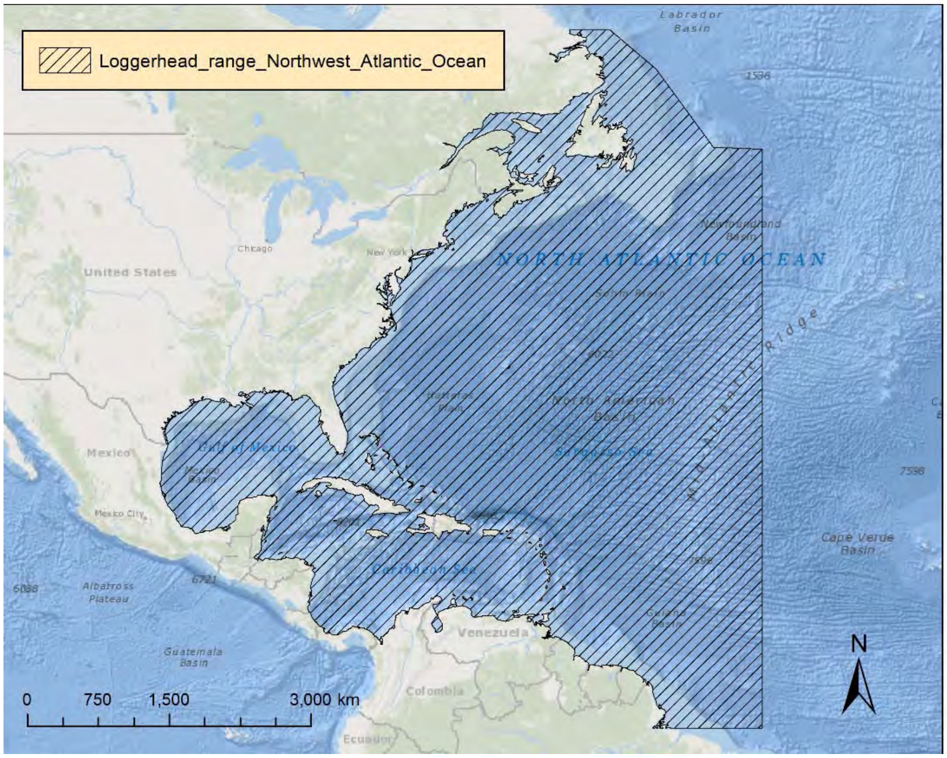

Figure 58. Map identifying the range of the Northwest Atlantic Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Northwest Atlantic Ocean DPS of loggerhead turtle listed as threatened (Table 46).

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.

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.

Population Dynamics

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

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS-SEFSC 2009). Based on genetic information, the Northwest Atlantic Ocean DPS of loggerhead turtle is further categorized into five recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit.

The Northern Recovery Unit, from North Carolina to northeastern Florida, and is the second largest nesting aggregation in the Northwest Atlantic Ocean DPS, with an average of 5,215 nests from 1989 through 2008, and approximately 1,272 nesting females (NMFS and USFWS 2008).

The Peninsular Florida Recovery Unit hosts more than 10,000 females nesting annually, which constitutes 87 percent of all nesting effort in the Northwest Atlantic Ocean DPS of loggerhead turtles (Ehrhart et al. 2003).

The Greater Caribbean Recovery Unit encompasses nesting sub-populations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003). Other significant nesting sites are found throughout the Caribbean Sea, and including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al. 2003), and over 100 nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008).

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

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

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

Nest counts taken at index beaches in Peninsular Florida show a significant decline in loggerhead sea turtle nesting from 1989 through 2006, most likely attributed to mortality of oceanic-stage loggerhead turtles caused by fisheries bycatch (Witherington et al. 2009). Loggerhead turtle nesting on the Archie Carr National Wildlife Refuge (representing individuals of the Peninsular Florida sub-population) has fluctuate over the past few decades. There was an average of 9,300 nests throughout the 1980s, with the number of nests increasing into the 1990s until it reached an all-time high in 1998, with 17,629 nests. From that point, the number of loggerhead turtle nests at the Archie Carr National Wildlife Refuge have declined steeply to a low of 6,405 in 2007, increasing again to 15,539, still a lower number of nests than in 1998 (Bagley et al. 2013).

For the Northern Recovery Unit, nest counts at loggerhead turtles nesting beaches in North Carolina, South Carolina, and Georgia declined at 1.9 percent annually from 1983 through 2005 (NMFS and USFWS 2007b).

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

Based on genetic analysis of nesting sub-populations, the Northwest Atlantic Ocean DPS of loggerhead turtle is further divided into five recovery units: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean (Conant et al. 2009). A more recent analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico’s Caribbean Sea coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS should be considered as ten management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

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

Loggerhead turtles hatchlings from the western Atlantic Ocean disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Mitochondrial DNA evidence demonstrates that juvenile loggerhead turtles from southern Florida nesting beaches comprise the vast majority (71 to 88 percent) of individuals found in foraging grounds throughout the western and eastern Atlantic Ocean: Nicaragua, Panama, Azores and Madeira, Canary Islands and Adalusia, Gulf of Mexico, and Brazil (Masuda 2010).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

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

Critical Habitat

On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS of loggerhead turtles along the U.S. Atlantic and Gulf of Mexico coasts from North Carolina to Mississippi (79 FR 39856) (Figure 59). These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. The critical habitat is categorized into 38 occupied marine areas and 1,102.4 km (685 miles) of nesting beaches. The physical and biological features (formerly primary constituent elements) identified for the different habitat types include waters adjacent to high density nesting beaches, waters with minimal obstructions and manmade structures, high densities of reproductive males and females, appropriate passage conditions for migration, conditions that support *Sargassum* habitat, available prey, and sufficient water depth and proximity to currents to ensure offshore transport of post-hatchlings.

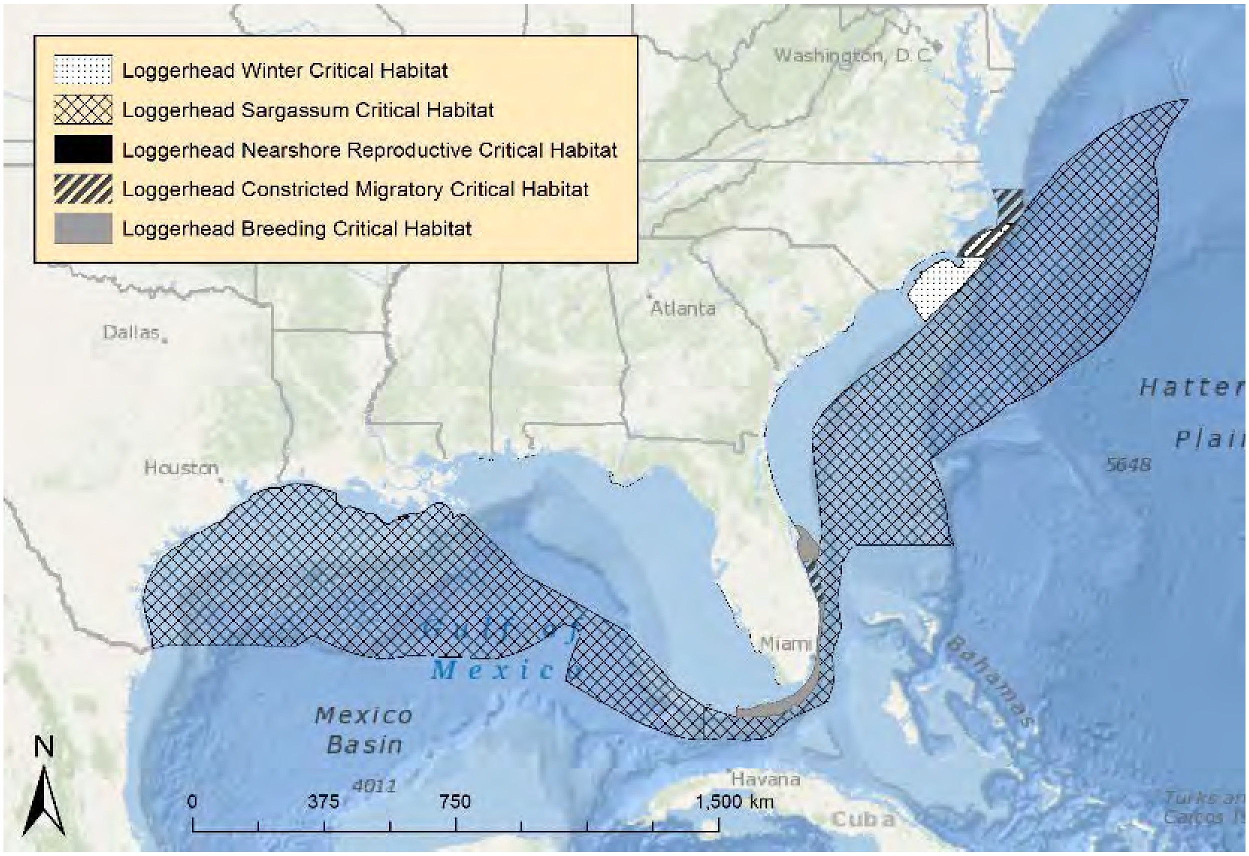

Figure 59. Map identifying designated critical habitat for the Northwest Atlantic Ocean distinct population segment of loggerhead turtle.

Recovery Goals

See the 2009 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads for complete downlisting/delisting criteria for each of the following recovery objectives:

1. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
2. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
3. Manage sufficient nesting beach habitat to ensure successfully nesting.
4. Manage sufficient feeding, migratory, and interesting marine habitats to ensure successful growth and reproduction.
5. Eliminate legal harvest.
6. Implement scientifically based nest management plans.
7. Minimize nest predation.
8. Recognize and respond to mass/unusual mortality or disease event appropriately.
9. Develop and implement local, state, Federal, and international legislation to ensure long-term protection of loggerhead turtles and their terrestrial and marine habitats.
10. Minimize bycatch in domestic and international commercial and artisanal fisheries.

11. Minimize trophic changes from fishery harvest and habitat alteration.
12. Minimize marine debris ingestions and entanglement.
13. Minimize vessel strike mortality.

5.46 Loggerhead Turtle – South Atlantic Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). South Atlantic Ocean DPS of loggerhead turtles are found in the South Atlantic Ocean, between the eastern coast of South America and the west coast of Africa (Figure 60).

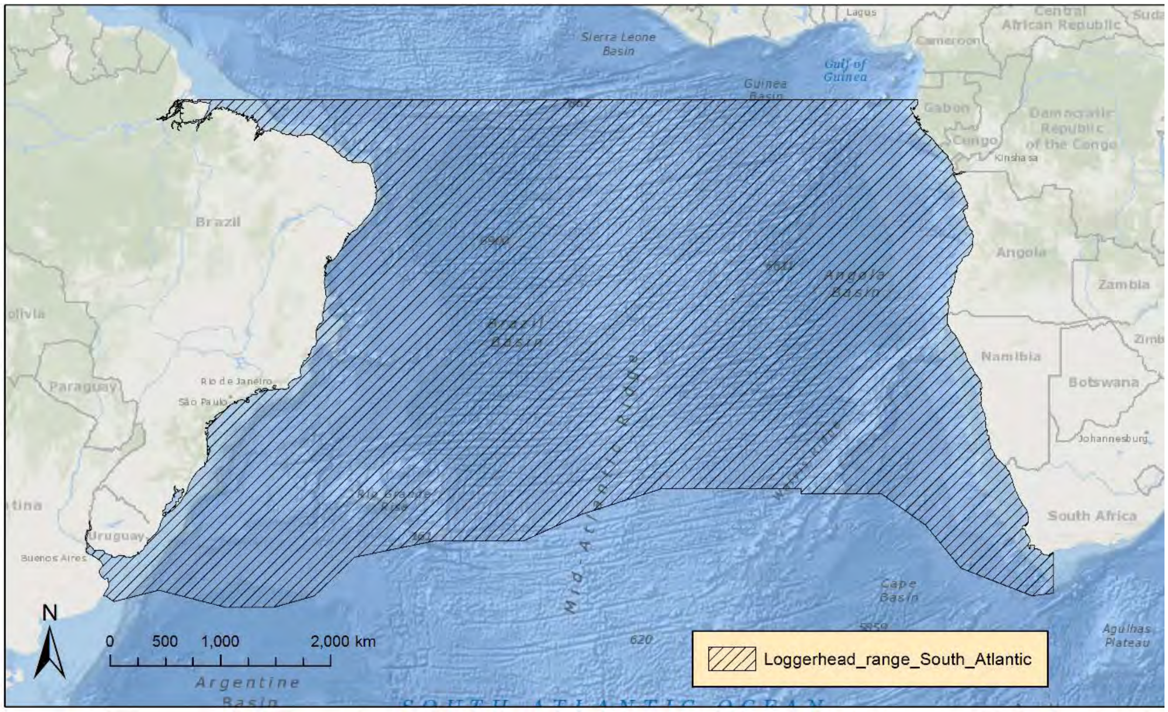

Figure 60. Map identifying the range of the South Atlantic Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the South Atlantic Ocean DPS listed as threatened (Table 46).

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.

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.

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 South Atlantic Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Loggerhead turtle nesting for the South Atlantic Ocean DPS occurs in Brazil, from the state of Rio de Janeiro to Sergipe, with the majority occurring in Bahia. Prior to 1980, population were severely depleted, but from 1988 through 2003, there was an increase in nesting abundance, with 4,837 nests counted during the 2003 and 2004 season (Marcovaldi and Chaloupka 2007). Population growth modeling indicates an increasing trend for the South Atlantic DPS (Conant et al. 2009).

Researchers examined tissue samples from loggerhead turtles at Brazilian rookeries and an oceanic foraging ground. The Brazilian rookeries had four haplotypes unique to Brazil, and the results suggest the existence of two Brazilian genetic stocks, a northern and a southern. The foraging aggregation had six haplotypes, indicating that individuals from outside Brazil forage in the region (Reis et al. 2009). More recent analysis of longer mitochondrial DNA sequences support distinguishing three genetically distinct management units: northern coast (Sergipe and Bahia), Espirito Santo, and Rio de Janerio (Shamblin 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.

Individuals from Brazilian nesting beaches are found in low proportions in feeding aggregations off of Panama (1.6 percent) and Nicaragua (1.3 percent) (Masuda 2010). In samples taken from a foraging aggregation in the South Atlantic Ocean, the Elevação do Rio Grande seamount, haplotypes from Brazil rookeries comprised about half of samples, with haplotypes from Masirah Island, Oman, Natal, South Africa, western Australia, and eastern Australia rookeries making up the rest (Shamblin et al. 2014). These results underscore the importance of recognizing the long-distance migratory patterns of loggerhead turtles, ocean currents, and the connectivity of the South Atlantic and Indian Ocean basins in assessing the population structure of foraging aggregations in the South Atlantic Ocean (Shamblin et al. 2014).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 μPa and two-year olds: about 86 dB re: 1 μPa), with threshold increasing rapidly above and below that frequency (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 μPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

Although there are increasing trends at nesting beaches over the past 20 years, the South Atlantic Ocean DPS of loggerhead turtle still faces significant mortality of juveniles in commercial and artisanal fisheries. The South Atlantic Ocean DPS is not currently at immediate risk of extinction, but the risk of extinction is likely to increase in the foreseeable future (Conant et al. 2009).

Critical Habitat

No critical habitat has been designated for the South Atlantic Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the South Atlantic Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.47 Loggerhead Turtle – South Pacific Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). South Pacific Ocean DPS of loggerhead turtles are found in the Pacific Ocean, south of the equator. Their range extends from eastern Australia to western South America (Figure 61).

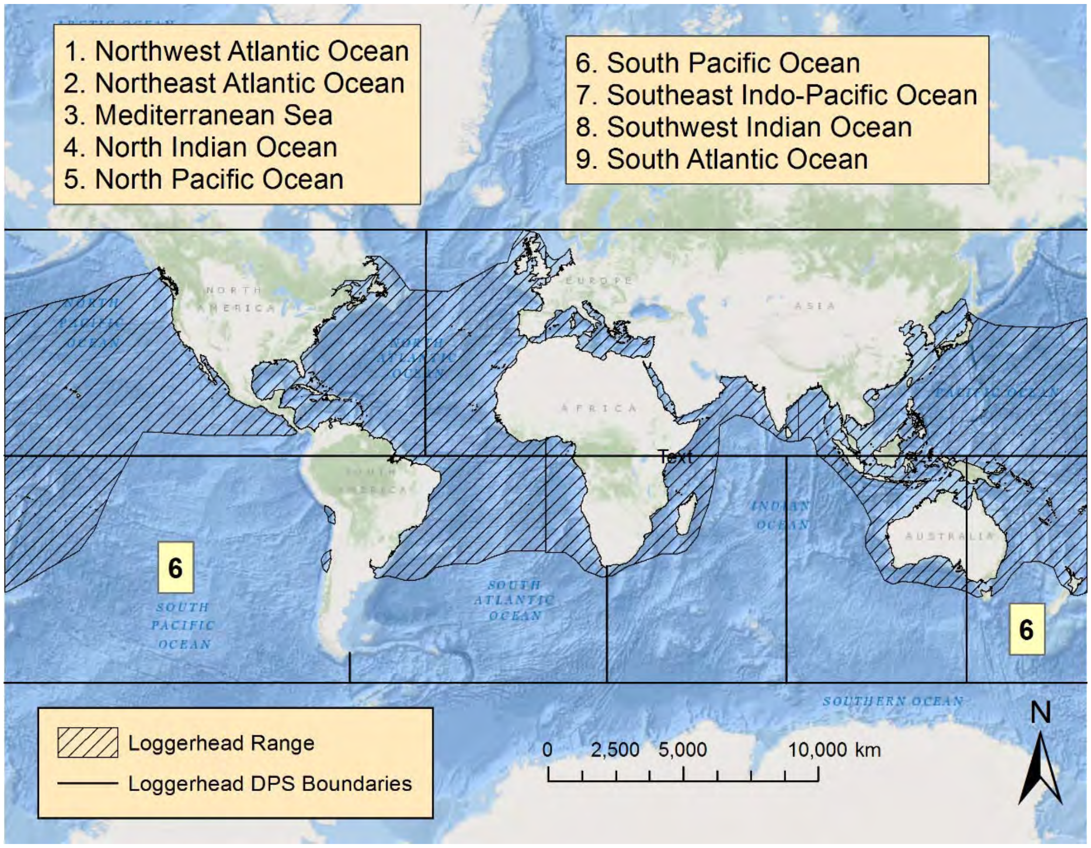

Figure 61. Map identifying the range of the South Pacific Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the South Pacific Ocean DPS of loggerhead turtle listed as endangered (Table 46).

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.

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.

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 South 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 et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Nesting for the South Pacific Ocean DPS of loggerhead turtles occurs mostly in eastern Australia and New Caledonia. New Caledonia has about 60 to 70 nesting females annually (Limpus et al. 2006); more recent estimates indicate about 200 nesting females per year (Wabnitz and Andréfouët 2008). Major nesting beaches in Australia occur in the central and south Queensland areas, with some small aggregations in New South Wales (Limpus 2008).

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. Eastern Australia supported one of the major global loggerhead turtles nesting assemblages until recently (Limpus 1985). For many years, the nesting population at Queensland was in decline; there were approximately 3,500 females in the 1976 and 1977 nesting season, and less than 500 in 1999, representing an 86 percent reduction in the size of the annual nesting population in 23 years (Limpus and Reimer 1994; Limpus 1985; Limpus and Limpus 2003). From 2000 through 2009, there has been an increasing number of females nesting (Conant et al. 2009). Despite that increase, the arithmetic mean of the log population growth rate calculated for various nesting beaches in eastern Australia range from -0.013 to -0.075 (Conant et al. 2009). Population modeling focusing on a nesting beach in Queensland, Australia indicates that the loss of only a few hundred adult and sub-adult females would lead to the extinction of the population in eastern Australia in less than one hundred years (Heppell et al. 1996).

South Pacific Ocean DPS of loggerhead turtles possess three haplotypes, including one dominant haplotype not found elsewhere (Conant et al. 2009).

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

Loggerhead turtles hatched on beaches in the southwest Pacific Ocean range widely in the southern portion of the basin, with individuals from nesting beaches in Western Australia found as far east as Peruvian coast foraging areas (Boyle et al. 2009). Loggerhead turtles from Australia and New Caldedonia do not appear to go north of the equator. Loggerhead turtles are also present in the waters offshore northern Chile and Peru, where they comprise the majority of sea turtle bycatch in commercial fisheries (Alfaro-Shigueto et al. 2011; Donoso and Dutton 2010).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

Based on nest count data from the past 30 years, and mortality of juveniles and adults from fishery bycatch, the South Pacific Ocean DPS of loggerhead turtle is at risk, and is likely to decline in the foreseeable future (Conant et al. 2009; Limpus 2008).

Critical Habitat

No critical habitat has been designated for the South Pacific Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the South Pacific Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.48 Loggerhead Turtle – Southeast Indo-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 (Figure 53). South Indo-Pacific Ocean DPS of loggerhead turtles are found in the Indian Ocean, in the waters around Western Australia, Indonesia, and Papua New Guinea (Figure 62).

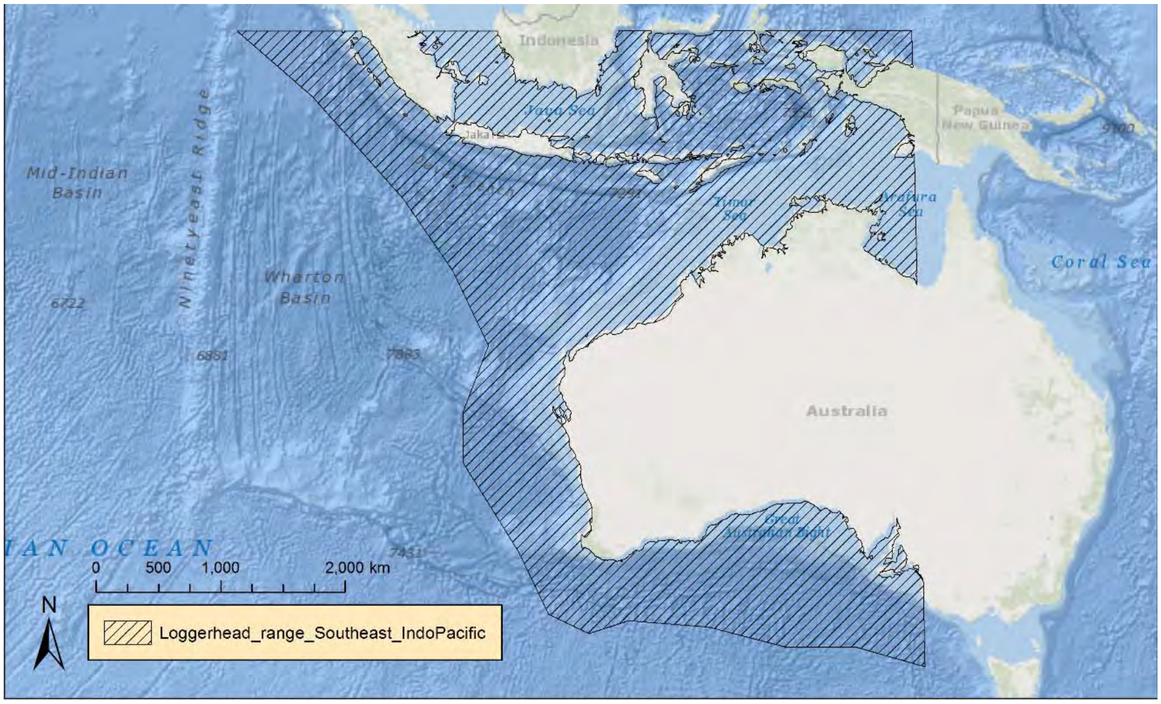

Figure 62. Map identifying the range of the Southeast Indo-Pacific Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Southeast Indo-Pacific Ocean DPS listed as threatened (Table 46).

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.

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.

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 Southeast Indo-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 et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Nesting for the Southeast Indo-Pacific Ocean DPS of loggerhead turtle is restricted to western Australia, with three main nesting beaches: Dirk Harog Island, Murion Island, and North West Cape (Baldwin et al. 2003). About 70 to 75 percent of females in the region nest at Dirk Hartog Island or about 800 to 1,500 females annually. The remainder nest at Murion Island (150 to 350 annually) and North West Cape (50 to 150 annually) (Baldwin et al. 2003). There was not sufficient time series nesting data to calculate population growth rates for the Southeast Indo-Pacific DPS in the 2009 status review (Conant et al. 2009).

Nesting for the Southeast Indo-Pacific DPS of loggerhead turtle occurs exclusively in western Australia, and mitochondrial DNA analysis has revealed high levels of genetic diversity, with nine haplotypes identified (Pacioni et al. 2012). Adult populations in the Southeast Indo-Pacific DPS are highly structured with no overlap among other adult loggerheads in the Indian Ocean basin (Conant et al. 2009).

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.

There is some variation in dispersal patterns of loggerhead turtles of the Southeast Indo-Pacific Ocean DPS. Tagged adult males in Western Australia exhibited relatively small areas (186 km^2 [54.2 nmi^2]) within coastal foraging areas (Olson et al. 2012). Stable isotope data analysis indicates that loggerhead turtles in Shark Bay, Western Australia, show strong fidelity to particular foraging areas over many years (Thomson et al. 2012). The Western Australia haplotype was present in individuals in a Brazilian foraging aggregation in the South Atlantic Ocean, indicating that loggerhead turtles from the Southwest Indian Ocean DPS may use major surface currents to migrate to a different ocean basin to forage (Shamblin et al. 2014).

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 et al. 1999b; Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

There was not adequate time series of nesting data for this Southeast Indo-Pacific DPS to evaluate extinction risk, so the Biological Review Team relied on modeling to determine the effects of threats to the Southeast Indo-Pacific DPS. The worst-case scenario deterministic model indicated that the Southeast Indo-Pacific Ocean DPS of loggerhead turtle is likely to substantially decline in the foreseeable future, mostly due to fisheries bycatch of juveniles and adults in the region (Conant et al. 2009).

Critical Habitat

No critical habitat has been designated for the Southeast Indo-Pacific Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southeast Indo-Pacific Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.49 Loggerhead Turtle – Southwest Indian Ocean Distinct Population Segment

Loggerhead turtles are circumglobal and are found in the temperate and tropical regions of the Pacific, Indian, and Atlantic Oceans (Figure 53). Southwest Indian Ocean DPS of loggerhead turtles are found in the southwestern Indian Ocean, off the coasts of Africa and Madagascar (Figure 63).

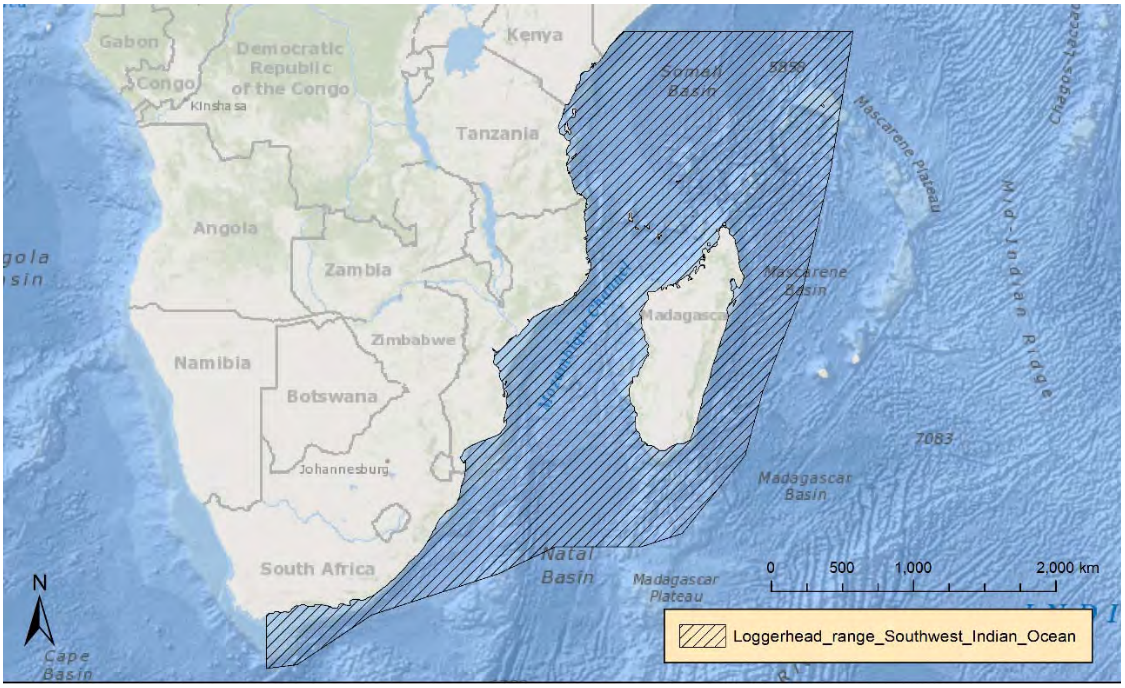

Figure 63. Map identifying the range of the Southwest Indian Ocean distinct population segment of loggerhead turtle.

The loggerhead turtle is distinguished from other sea turtles by it reddish-brown carapace, large head, and powerful jaws. The species was first listed as threatened under the ESA in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPSs of loggerhead turtles, with the Southwest Indian Ocean DPS listed as threatened (Table 46).

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.

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.

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 Southwest Indian Ocean DPS of loggerhead turtle.

There is a general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are no doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one percent of total population numbers (Bjorndal et al. 2005). The global abundance of nesting female loggerhead turtles is estimated at 43,320 to 44,560.

Nesting for the Southwest Indian Ocean DPS of loggerhead turtle is confined to South Africa and Mozambique. An average of over 400 female loggerhead turtles nest annually at beaches in the Natal province of South Africa, with an estimated 500 to 2,000 females nesting throughout South Africa (Baldwin et al. 2003; Hughes 1996). Less than 100 females nest annually in Mozambique (Baldwin et al. 2003).

The Southwest Indian Ocean DPS of loggerhead turtle exhibits an increasing population trend (Conant et al. 2009), one of only two loggerhead turtles DPSs worldwide that show signs of increase. A single unique haplotype was present in specimens from Natal, South Africa (Shamblin 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.

Adult females tagged in Madagascar traveled to feeding grounds off South Africa and Mozambique (Luschi et al. 2003b). There is also evidence that Southwest Indian Ocean DPS loggerhead turtles travel further distances. The Natal, South Africa haplotype was present in individuals in a Brazilian foraging aggregation in the South Atlantic Ocean, indicating that loggerhead turtles from the Southwest Indian Ocean DPS may use major surface currents, like the Agulhas current, to migrate to a different ocean basin to forage (Shamblin et al. 2014).

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 et al. 1999b;

Lenhardt 1994; Lenhardt 2002; Moein Bartol and Ketten 2006; Ridgway et al. 1969). Hearing below 80 Hz is less sensitive but still possible (Lenhardt 1994). Bartol et al. (1999b) reported effective hearing range for juvenile loggerhead turtles is from at least 250 to 750 Hz. Both yearling and two-year old loggerhead turtles had the lowest hearing threshold at 500 Hz (yearling: about 81 dB re: 1 µPa and two-year olds: about 86 dB re: 1 µPa), with threshold increasing rapidly above and below that frequency (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 µPa at 100 Hz. Lavender et al. (2014) found post-hatchling loggerhead turtles responded to sounds in the range of 50 to 800 Hz while juveniles responded to sounds in the range of 50 Hz to 1 kHz. Post-hatchlings had the greatest sensitivity to sounds at 200 Hz while juveniles had the greatest sensitivity at 800 Hz (Lavender et al. 2014).

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

Status

There is limited information available on anthropogenic mortality for loggerhead turtles in the Southwest Indian Ocean DPS, leading to wide ranges of estimates on total mortality. There are increasing trends in females at nesting beaches from 1963 through 1999 at Maputaland (Natal), South Africa. Although the Southwest Indian Ocean DPS of loggerhead turtle is not currently at immediate risk of extinction, the extinction risk is likely to increase in the foreseeable future (Conant et al. 2009).

Critical Habitat

No critical habitat has been designated for the Southwest Indian Ocean DPS of loggerhead turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals

NMFS has not prepared a Recovery Plan for the Southwest Indian Ocean DPS of loggerhead turtle. In general, ESA-listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296).

5.50 Olive Ridley Turtle

The olive ridley turtle is a small, mainly pelagic, sea turtle with circumtropical distribution (Figure 64).

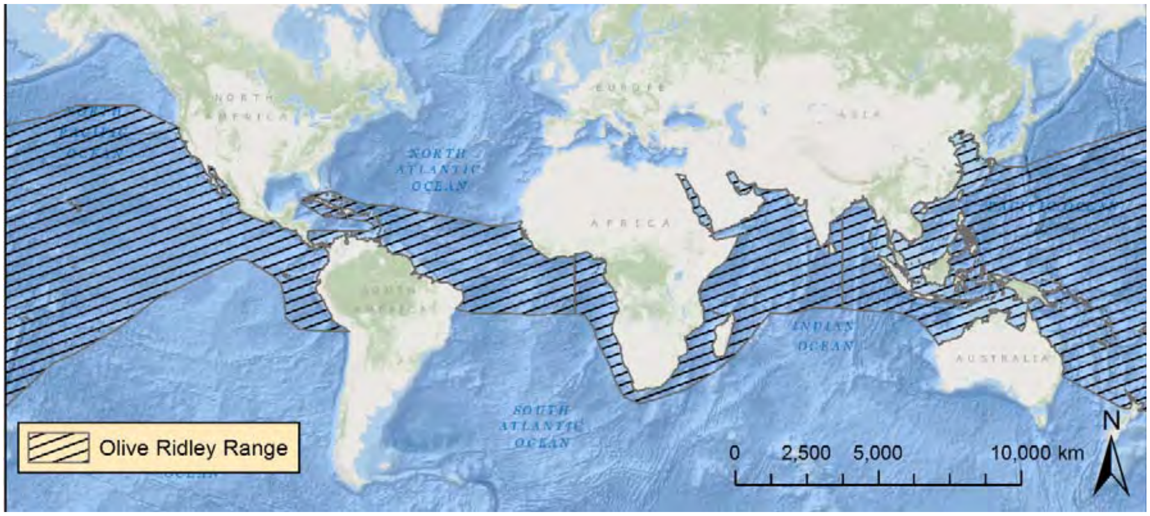

Figure 64. Map identifying the range of the olive ridley turtle.

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) (Table 46).

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

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.

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 endangered range-wide population of the olive ridley turtle and endangered Pacific coast of Mexico breeding population of the olive ridley turtle (NMFS and 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 one million nesting females annually. There are several monitored nesting beaches where solitary nesting occurs. At Nuevo Vallarta, about 4,900 nests are laid annually.

In the Western Atlantic Ocean, two arribada nesting beaches occur in Suriname and French Guiana. The Cayenne Peninsula in French Guiana hosts about 2,000 nests annually, while the Galibi Nature Reserve in Suriname had 335 nests in 1995. Solitary nesting also occurs elsewhere in Suriname, Guyana, and French Guiana; although no abundance estimates are available. In Sergipe, Brazil, solitary nesting amounted to about 2,600 nests in 2002 and 2003.

In the Eastern Atlantic Ocean, there are no arribada nesting beaches, but solitary nesting occurs in several countries along the western coast of Africa, from Gambia to Angola. For many countries, there are no abundance estimates available. For beaches with data available (Angola, the Republic of Congo, the Democratic Republic of Congo, Equatorial Guinea, and Guinea Bissau), nest counts are low, with most monitoring taking place for only a few years. The most abundant nesting beaches are Orango National Park in Guinea Bissau, which had between 170 and 620 nests from 1992 through 1994; and the Republic of Congo, which had between 300 and 600 nests annually from 2003 through 2010 (NMFS and USFWS 2014).

In the Indian Ocean, three arribada nesting beaches are found in India, amounting to 150,000 to 200,000 nesting females annually. Solitary nesting also occurs elsewhere in the region, in eastern Africa, Oman, India, Pakistan, and other Southeast Asian countries; for many, there are no estimates available. The largest recorded nesting beach is in Myanmar, when in 1999, 700 nests were counted (NMFS and USFWS 2014).

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 (Gago et al. 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 sea turtles per arribada, and Nancite has between 256 and 41,149 sea turtles per arribada. Panama has one arribada nesting beach, with 8,768 sea 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 (NMFS and 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 (NMFS and USFWS 2014).

Nesting at arribada beaches in French Guiana appears to be increasing, while in Suriname, nesting has declined by more than 90 percent since 1968. Solitary nesting also occurs elsewhere in Suriname, Guyana, and French Guiana; no trend data are available. Solitary nesting in Brazil appears to be increasing, with one hundred nests recorded in 1989 to 1990, to 2,606 in 2002 through 2003.

In the Eastern Atlantic Ocean, trend data is not available for most solitary nesting beaches. Nest counts in the Republic of Congo decreased from 600 nests in 2003 and 2004 to less than 300 in 2009 and 2010.

The three arribada nesting beaches in India – Gahirmatha, Rushikulya, and Devi River – are considered stable over three generations. There is no trend data available for several solitary nesting beaches in the Indian Ocean. However, even for the few beaches with short-term monitoring, the nest counts are believed to represent a decline from earlier years.

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 (NMFS and USFWS 2014).

Globally, olive ridley turtles can be found in tropical and sub-tropical waters in the Atlantic, Indian, and Pacific Oceans (Figure 64). 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.

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 and Vernon 1956). Wood turtles are sensitive up to about 500 Hz, followed by a rapid decline above 1 kHz and almost no responses beyond 3 to 4 kHz (Patterson 1966).

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 ten million 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.

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.

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.

6 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 CFR §402.02). The environmental baseline for this opinion includes the effects of several activities that affect the survival and recovery of ESA-listed resources in the SURTASS LFA sonar action area.

6.1 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° C 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 Eliott. 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, 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. (2009b) 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 may outpace sea turtles' ability to adapt.

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

This 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.

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

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

A strong association has been established between the variability of the North Atlantic oscillation and changes affecting various trophic groups in North Atlantic marine ecosystems on both the eastern and western sides of the basin (Drinkwater et al. 2003; Fromentin and Planque 1996). For example, the temporal and spatial patterns of *Calanus* copepods (zooplankton) were the first to be linked to the phases of the North Atlantic oscillation (Fromentin and Planque 1996; Stenseth et al. 2002). When the North Atlantic oscillation index was positive, the abundance of *Calanus* copepods in the Gulf of Maine increased, with the inverse true in years when the North Atlantic oscillation index was negative (Conversi et al. 2001; Greene et al. 2003b). This pattern is opposite off the European coast (Fromentin and Planque 1996). Such a shift in copepod patterns has a tremendous significance to upper-trophic-level species, including the North Atlantic right whale, which feeds principally on *Calanus finmarchicus*. North Atlantic right whale calving rates are linked to the abundance of *Calanus finmarchicus*; when the abundance is high, the calving rate remains stable but fell in the late 1990s when the abundance of its favored copepod also declined (Greene et al. 2003a). When the North Atlantic oscillation index is low with subsequently warmer water temperatures off Labrador and the Scotian Shelf, recruitment of cod is higher; direct links to the North Atlantic oscillation phase have also been found for recruitment in the North Atlantic of herring, two tuna species, Atlantic salmon, and swordfish (Drinkwater et al. 2003).

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 decadel 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.

The Indian Ocean Dipole, which is also known as the Indian Niño, is an irregular oscillation of sea surface temperature in which the western Indian Ocean becomes alternately warmer and then colder than the eastern part of the ocean (Saji et al. 1999). The Indian Ocean dipole, only identified recently in 1999, is one aspect of the general cycle of global climate, interacting with similar phenomena like the El Niño Southern Oscillation in the Pacific Ocean. As in the Pacific decadal oscillation and North Atlantic oscillation, the Indian Ocean dipole fluctuates between phases of positive, negative, and neutral conditions. During a positive Indian Ocean dipole, the western Indian Ocean experiences higher than normal sea surface temperature and greater precipitation while cooler sea surface temperature occur in the eastern Indian Ocean, often leading to droughts on land in the region (Saji et al. 1999). The negative phase of the Indian Ocean dipole brings about the opposite conditions, with warmer sea surface temperatures and greater precipitation in the eastern Indian Ocean and cooler and drier conditions in the western Indian Ocean. The Indian Ocean dipole also affects the strength of monsoons over the Indian subcontinent. An average of four positive and negative Indian Ocean dipole events occurs during each 30-year period, with each Indian Ocean dipole event lasting about six months. However, since 1980 there have been 12 positive Indian Ocean dipoles with no negative Indian Ocean dipole events from 1992 until late in 2010, when a strong negative event began (Nakamura et al. 2009). This strong negative Indian Ocean dipole event coupled with a strong La Niña event in the western Pacific Ocean to cause catastrophic flooding in parts of Australia. In 1998, an El Niño even interacted with a positive Indian Ocean dipole event with devastating effect on Western Indian Ocean corals: 75 to 99 percent of live corals were lost in the western Indian Ocean during this event (Graham et al. 2006).

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° C and this trend is continuing at an accelerating pace. Twelve of the warmest years on record since 1850 have occurred since 1995 (Poloczanska et al. 2009a). 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 sear 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).

6.3 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).

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. 2008b). While the disease appears to have regressed over time (Chaloupka et al. 2009), 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, waste-water management practices, and invasive macro algae.

6.4 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 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.

6.5 Pollution

Anthropogenic activities such as discharges from wastewater systems, dredging, ocean dumping and disposal, aquaculture, and additional impacts from coastal development are known to degrade coastal waters utilized by ESA-listed marine mammals and sea turtles in the action area. Multiple municipal, industrial, and household sources as well as atmospheric transport introduce various pollutants such as pesticides, hydrocarbons, organochlorides, and other pollutants that may cause adverse health effects to ESA-listed marine mammals (Garrett 2004; Grant and Ross 2002; Hartwell 2004; Iwata et al. 1993; Ross 2002). 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. 2007b). 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).

6.5.1 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, 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 study 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 degrade slowly and many plastics float. The floating debris is transported by currents throughout the oceans and has been discovered accumulating in oceanic gyres (Law et al. 2010). Additionally, plastic waste in the ocean chemically attracts hydrocarbon pollutants such as PCB and DDT. Fish, marine mammals, and sea turtles can mistakenly consume these wastes containing elevated levels of toxins instead of their prey. In the North Pacific Subtropical Gyre it is estimated that the fishes in this area are ingesting 10,886,216 to 21,772,433 kg (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.

6.5.2 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 pollutants through trophic transfer may cause mortality and sub-lethal effects in long-lived high trophic level animals (Waring et al. 2004), including immune system abnormalities, endocrine disruption, and reproductive effects (Krahn et al. 2007a). Some researchers have correlated contaminant exposure to possible adverse health effects in marine mammals. 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. Due to their large amount of blubber and fat, marine mammals readily accumulate lipid-soluble contaminants (O'Hara and Rice 1996). Recent efforts have led to improvements in regional water quality and monitored pesticide levels have declined, although the more persistent chemicals are still detected and are expected to endure for years (Grant and Ross 2002; Mearns 2001).

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

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

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

It appears that levels of organochlorines have the potential to suppress the immune system of loggerhead turtles and may affect metabolic regulation (Keller et al. 2004b; Keller et al. 2006b; Oros et al. 2009). These contaminants could cause deficiencies in endocrine, developmental, and reproductive health (Storelli et al. 2007a) and are known to depress immune function in loggerhead turtles (Keller et al. 2006b). 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).

6.5.3 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, but aged oil having no detectable effects (Fritts and McGehee 1981).

6.6 Fisheries

Fisheries constitute an important and widespread use of the ocean resources throughout the action area. Fisheries can adversely affect fish populations, other species, and habitats. Direct effects of fisheries interactions 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., list fishing gear continuing to ensnare fish and other marine animals), and generation of marine debris. Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats and have the potential to entangle or be ingested by marine mammals.

Fisheries 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. An estimated 50 to 1,180 Steller sea lions are shot annually (Atkinson et al. 2008). Also, monk seals have been killed in recent years. Pinnipeds are also injured and killed accidentally as a result of being hooked by longline fisheries, entangled in fishing line, and entangled in gillnet, trawl, and other net-based fisheries. Commercial fishing is estimated to incidentally kill approximately 30 Steller sea lions annually (Atkinson et al. 2008). Hookings and entanglement in fishing gear represent major threats to Hawaiian monk seals. 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).

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, including sharks, mammals, marine birds, and sea turtles (Wallace et al. 2010a). Harvest from small-scale fisheries in the tropical Pacific Ocean in general is usually underestimated in official statistics due to the difficulty and costs of quantifying these very spatially diverse fisheries (Zeller et al. 2007). Marine mammals are known to feed on several species of fish that are harvested by humans (Waring et al. 2008). Thus, competition with humans for prey is a potential concern. Reductions in fish populations, whether natural or human-caused, may affect the survival and recovery of several populations.

6.7 Bycatch

The term "bycatch" refers to any fisheries capture that is incidental to the intended or targeted species and can encompass all unwanted, unmanaged, or discarded animals captured. Bycatch in the action area occurs both as a result of nearshore fisheries based in Guam, Commonwealth of the Northern Mariana Islands, and Hawaii, as well as large-scale offshore fisheries operated by foreign fishing fleets. Bycatch is likely the most impactful problem presently facing cetaceans worldwide and may account for the deaths of more marine mammals than any other cause (Geijer and Read 2013; Hamer et al. 2010; Northridge 2008; Read 2008). 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.

Fishery interaction remains a major factory in sea turtle recovery. Wallace et al. (2010b) estimated that worldwide, 447,000 sea turtles are killed each year from bycatch in commercial fisheries. NMFS (2002a) 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.

6.8 Aquaculture

Aquaculture has the potential to impact protected species via entanglement and/or other interaction with aquaculture gear (i.e., buoys, nets, and lines), introduction or transfer of pathogens, increased vessel traffic, impacts to habitat and benthic organisms, and water quality (NMFS 2015e; NOAA 2017).

6.9 Whaling

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

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

Under current International Whaling Commission regulations, aboriginal subsistence whaling is permitted for Denmark (Greenland, fin and minke whales), the Russian Federation (Siberia, gray and bowhead whales), St. Vincent and the Grenadines (Bequia, humpback 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 2012a). 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 done by Japan and Iceland. 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.

In Iceland, the stated overall objective of the research program was to increase understanding of the biology and feeding ecology of important cetacean species in Icelandic waters for improved management of living marine resources based on an ecosystem approach. While Iceland stated that its program was intended to strengthen the basis for conservation and sustainable use of cetaceans, it noted that it was equally intended to form a contribution to multi-species management of living resources in Icelandic waters.

Many of the whaling numbers reported represent minimum catches, as illegal or underreported catches are not included. For example, recently uncovered Union of Soviet Socialists Republics catch records indicate extensive illegal whaling activity between 1948 and 1979 (Ivashchenko et al. 2014). Additionally, despite the moratorium on large-scale commercial whaling, catch of some of these species still occurs in the Atlantic and 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 in the Atlantic, Indian, and Pacific Oceans. For example, the North Atlantic right whale, 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 Atlantic, Indian, and Pacific Oceans.

6.10 Sealing

Seals, sea lions, and fur seals have been hunted by humans for centuries for their fur, meant, and oil. Two species (Caribbean monk seal [*Monichus 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 Guadalupe fur seal), and many species were severely depleted. While hunting was previously the primary cause of population decline among ESA-listed pinnipeds, it no longer represents a major threat. Hunting of Hawaiian monk seals and Guadalupe fur seals is illegal, while limited subsistence hunting of Steller sea lions, bearded seals, and ringed seals is permitted.

6.11 Sea Turtle Harvest

Directed harvest of sea turtles and their eggs for food and other products has existed for years and was a significant factor causing the decline of green, 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 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.

6.12 Scientific Research

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

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

ESA-listed pinniped research includes approach, capture, handling, restraint, biopsy, nail clip, blood and tissue sampling, anesthesia, temporary captivity, tagging, translocation, swab sampling, lavage, hot branding, tooth extraction, ultrasound, and mortality. Most research involves sub-lethal take (e.g., capture and release), but unintentional and intentional mortalities were permitted annually. Lethal take of male Hawaiian monk seals has been authorized in specific instances of mobbing. The removal of specific males involved in mobbing preserves the health of female and young individuals that will provide greater contributions to the survival and recovery of the species. For Western DPS of Steller sea lions, most authorized take is sub-lethal (e.g., capture and release), but some unintentional mortalities are authorized annually.

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.

6.13 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 kph (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. It should be noted that, unlike other maritime entities, the Navy has a policy to report all vessel strikes.

Of the eleven species known to be hit by ships, fin whales are stuck most frequently, and right whales, humpback whales, sperm whales, and gray whales are also hit commonly (Laist et al. 2001; Vanderlaan and Taggart 2007). In some areas, one-third of all fin whale and right whale strandings appear to involve vessel strikes (Laist et al. 2001). The effects of vessel strikes are particularly profound on species with low abundance, such as North Atlantic right whales.

Vessel strikes 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 (2.2 nmi) 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.

6.14 Vessel Approaches – Commercial and Private Marine Mammal Watching

Whale watching is a rapidly growing business with more than 3,300 operators worldwide, serving 13 million participants in 119 countries and territories (O’Connor et al. 2009). As of 2010, commercial whale watching was a one billion dollar global industry per year (Lambert et al. 2010). Private vessels may partake in this activity as well. Whale watching, particularly of humpback whales, is extensive in Hawaiian waters during the winter. NMFS has issued certain regulations and guidelines relevant to whale watching. For example, under 50 CFR §224.103, except as authorized under the MMPA and ESA, federal regulations prohibit approaching (by any means) humpback whales within 100 yards when on or in the water, and within 305 m (1,000 ft) when operating an aircraft within 370 km (200 nmi) of the Islands of Hawaii. As noted previously, many of the cetaceans considered in this opinion are highly migratory, so may also be exposed to whale watching activity occurring outside of the action area.

Although considered by many to be a non-consumptive use of marine mammals with economic, recreational, educational and scientific benefits, marine mammal watching is not without potential negative impacts. Whale watching has the potential to harass whales by altering feeding, breeding, and social behavior or even injure them if the vessel gets too close or strikes the whale. Preferred habitats may be abandoned if disturbance levels are too high. The interactions that individuals may experience in Hawaiian waters likely influence how they react to approaches by vessels in the future (Herman 1979). Animals may also become more vulnerable to vessel strikes if they habituate to vessel traffic (Swingle et al. 1993; Wiley et al. 1995).

Several studies have examined the short-term effects of whale watch vessels on marine mammals (Amaral and Carlson 2005; Au and Green 2000a; Corkeron 1995; Erbe 2002b; Felix 2001; Magalhaes et al. 2002; Richter et al. 2003a; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002b). The whale's behavioral responses to whale watching vessels depended on the distance of the vessel from the whale, vessel speed, vessel direction, vessel noise, and the number of vessels. In some circumstances, the whales did not respond to the vessels, but in other circumstances, whales changed their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. Foote et al. (2004) reported that Southern Resident DPS of killer whale call duration in the presence of whale watching boats increased by 10 to 15 percent from 1989 through 1992 and 2001 through 2003, possibly indicating compensation for a noisier environment. Disturbance by whale watch vessels has also been noted to cause newborn calves to separate briefly from their mother's sides, which leads to greater energy expenditures by the calves (NMFS 2006b)

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

It is difficult to precisely quantify or estimate the magnitude of the risks posed to marine mammals in general from vessel approaches. Given the SURTASS LFA sonar sound fields greater than 180 dB re: 1 µPa (rms) will not occur in areas with 22 km (12 nmi) of land, few whale watching boats would be expected to co-occur with the SURTASS LFA sonar vessels.

6.15 Conservation and Management Efforts

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

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

Conservation and management efforts for marine mammals and sea turtles are also implemented independent of NMFS. For example, and most notably for cetaceans, in 1946, the International Convention for the Regulation of Whaling began regulating commercial whaling and in 1966, the International Whaling Commission prohibited commercial whaling.

6.16 Underwater Sound

The ESA-listed species that occur in the action area are regularly exposed to several sources of natural and anthropogenic sounds. Natural sounds include wind and waves, precipitation, seismic phenomena, and biological sounds (e.g., from marine mammals). Anthropogenic noises include, but are not limited to, maritime activities, dredging, construction; mineral exploration in offshore areas; geophysical (seismic) surveys; sonars; explosions; and ocean research activities. Ambient noise is the background level of sound in the environment and is caused by naturally-occurring physical and biological sources as well as anthropogenic sources. Ambient noise levels are higher in the northern hemisphere, where sources of anthropogenic sounds are more pervasive. However, even in relatively quiet regions in the southern hemisphere, ambient noise levels commonly vary by 20 dB and will vary by 30 dB with lower frequency because of biological sources and sea surface noise (Cato and McCauley. 2001). Below, we discuss both natural and anthropogenic noise sources that collectively contribute to the total noise at any one place and time. ESA-listed species have the potential to be impacted by either increased levels of anthropogenic-induced background noise or high intensity, short-term anthropogenic sounds.

6.16.1 Natural Sources

There are numerous natural sources of noise that have low frequencies that are comparable to SURTASS LFA sonar, such as:

- *Wind and waves* are common and interrelated sources of ambient noise in all of the world’s oceans. All other factors being equal, ambient noise levels tend to increase with increasing wind speeds and wave height (Richardson et al. 1995e). Noise generated by surface wave activity is one of the two primary contributors to ambient noise in the frequency range from 300 Hz to 5 kHz. The wind-generated noise level decreases smoothly with increasing acoustic frequency (i.e., there are not spikes at any given frequency).
- *Precipitation*. At some frequencies, rain and hail will increase ambient noise levels. Significant noise is produced by rain squalls over a range of frequencies from 500 Hz to 15 kHz. Large storms with heavy precipitation can generate noise at frequencies as low as 100 Hz and significantly affect ambient noise levels at a considerable distance from a storm’s center. Lightning strikes associated with storms are loud, explosive events that deliver an average of 100 kiloJoules per meter of energy (Considine 1995). Hill (1985) estimated that source level for cloud-to-water pulse to be 260.5 dB. It has been estimated that over the earth’s oceans the frequency of lightning averages about ten flashes per second, or 314 million strikes per year (Kraght 1995).
- *Seismic Phenomena*. Underwater volcanic eruptions, earthquakes, and landslides produce sound in the frequency range of 1 to 100 Hz. In the Pacific Ocean, where the majority of seismic activity occurs in the world’s oceans, about 10,000 natural, seismic phenomena occur each year (Fox et al. 2001). Hill (1985) stated that these phenomena produce sounds with source levels exceeding 255 dB re: 1 µPa at 1 m.
- *Biological Noise*. Sounds created by animals in the sea and may contribute significantly to ambient noise in many areas of the oceans (Curtis et al. 1999). Because of the habits, distribution, and acoustic characteristics of these sound producers, certain areas of the oceans are louder than others. Only three groups of marine animals are known to make sounds: crustaceans (such as snapping shrimp), fish, and marine mammals (Urick 1983). The most widespread, broadband noises from animal sources (in shallow water) are those produced by croakers (representative of a variety of fish classified as drumfish) (100 Hz to 10 kHz) and snapping shrimp (500 Hz to 20 kHz). Sound-producing fishes and crustaceans are restricted almost entirely to bays, reefs, and other coastal waters, although there are some pelagic, sound-producing fish. In oceanic waters, whales and other marine mammals are principal contributors to biological noise. For example, dolphins produce whistles associated with certain behaviors, and the baleen whales are noted for their low frequency vocalizations.

6.16.2 Anthropogenic Sources

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

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

Despite the potential for these impacts to affect individual ESA-listed marine mammals and sea turtles, information is not currently available to determine the potential population level effects of anthropogenic sound levels in the marine environment (MMC 2007). More information would be required including, but not limited to, empirical data on how sound impacts an individual’s growth and vital rates, how these changes impact that individual’s ability to reproduce successfully, and then the relative influence of that individual’s reproductive success on the population being considered. As a result, the consequences of anthropogenic sound on threatened and endangered marine mammals and sea turtles at the population or species scale remain uncertain.

6.16.2.1 *Oil and Gas Exploration*

Seismic surveys using towed airguns occur in the action area and are the primary exploration technique to locate oil and gas deposits, fault structure, and other geological hazards. Airguns generate intense high-energy impulsive sound pressure waves at low frequencies capable of penetrating the seafloor and are fired repetitively at intervals of ten to 20 seconds for extended periods (NRC 2003b). 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 2003b). Most of the sound energy is at frequencies below 500 Hz.

As a general mitigation measure for seismic surveys in U.S. waters or vessels under U.S. regulations, airguns are shut-down if marine mammals approach too closely (generally within 180 dB isopleths for cetaceans), presumably avoiding the potential for permanent threshold shifts in cetaceans exposed to the airgun pulses. While onboard observers and passive acoustic monitoring help identify the presence of whales, the possibility exists that some non-vocalizing whales beneath the surface may be temporarily exposed to higher sound levels at an unspecified degree. In addition to possible physical trauma and stress, whales are known to respond behaviorally by actively avoiding the sound of the seismic survey vessel, thus causing some temporary habitat displacement upon exposure (Gallagher and Hall. 1993; George 2010; Green and Ortiz-Crespo 1982; Richardson et al. 1995e; Richardson et al. 2004; Richardson et al. 1985c; Richardson and Williams 2003; Richardson and Williams 2004; Richardson et al. 1990; Schick and Urban 2000; Streever et al. 2008; Wartzok et al. 1989). In the U.S., most seismic surveys for oil and gas purposes and research activities involving the use of airguns with the potential to take marine mammals pursue consultations for incidental take authorizations under the MMPA.

The northern U.S. Gulf of Mexico is the location of massive industrial activity associated with oil and gas extraction and processing. Over 4,000 oil and gas structures are located outside of state waters in the northern Gulf of Mexico; 90 percent of these occur off Louisiana and Texas (USN 2009). This is both detrimental and beneficial for sea turtles. These structures appreciably increase the amount of hard substrate in the marine environment and provide shelter and foraging opportunities for species like loggerhead turtles (Parker et al. 1983; Stanley and Wilson 2003). However, the Bureau of Ocean Energy Management requires that structures must be removed within one year of lease termination. Many of these structures must be removed within one year of lease termination. Many of these structures are removed by explosively severing the underwater supportive elements, which produces a shock wave that kills, injures, or disrupts marine life in the blast radius (Gitschlag et al. 1997). For sea turtles, this means death or serious injury for individuals within a few hundred meters of the structure and overt behavioral (potentially physiological) impacts for individuals further away from the structure (Duronslet et al. 1986; Klima et al. 1988). Although visual observers and procedures are in place to mitigate impacts to sea turtles (i.e., not blasting when sea turtles are present), not all sea turtles are observed all the time, and low-level sea turtle injury and mortality still occurs (Gitschlag and Herczeg 1994; Gitschlag et al. 1997). Loggerhead and Kemp’s ridley turtles have been reported to be killed and stunned (sub-lethal injuries) over the past five years (Gitschlag 2015).

6.16.2.2 *Vessel Noise and Commercial Shipping*

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

Individual vessels produce unique acoustic signatures, although these signatures may change with ship speed, vessel load, and activities that may be taking place on the vessel. Peak spectral levels for individual commercial ships are in the frequency band of ten to 50 Hz and range from 195 dB re: $\mu Pa^2/Hz$ at 1 m for fast-moving (greater than 20 knots) supertankers to 140 dB re: $\mu Pa^2/Hz$ at 1 m for small fishing vessels (NRC 2003b). Small boats with outboard or inboard engines produce sound that is generally highest in the mid-frequency (one to five kHz) range and at moderate (150 to 180 dB re: 1 µPa at 1 m) source levels (Erbe 2002b; Gabriele et al. 2003; Kipple and Gabriele 2004). On average, noise levels are higher for the larger vessels, and increased vessel speeds resulted in higher noise levels.

Measurements made over the period 1950 through 1970 indicated low frequency (50 Hz) ship traffic noise in the eastern North Pacific and western North Atlantic Oceans was increasing by 0.55 dB per year. Data obtained in the northeast Pacific from 1978 to 1986 suggest the 0.55 dB per year increase seen in the early data continued to around 1980, but then slowed to about 0.2 dB per year (Chapman and Price 2011). Data obtained in the northeast Pacific Ocean from 1978 through 1986 suggest the 0.55 dB per year increase seen in the early data continued to around 1980, but then slowed to about 0.2 dB per year (Chapman and Price 2011). Hildebrand (2009) documented a three dB per decade increase in ambient noise in the 40 Hz band staring in the late 1950s (Hildebrand 2009a). Similar trends were documented in the Indian Ocean with the most prominent increases in ocean noise occurring in the 85 to 105 Hz band. The authors noted that this increase was consistent with concurrent increases in shipping, wind speed, wave height, and blue whale abundance in the Indian Ocean (Miksis-Olds et al. 2013).

6.16.2.3 *Air Force Training and Testing Activities*

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

6.16.2.4 *Navy Range Complex Training and Testing Activities*

The Navy conducts training, testing, and other military readiness activities on range complexes throughout coastal and offshore areas in the U.S. and on the high seas. Activities are conducted off the Atlantic coast and in the Gulf of Mexico, in the Gulf of Alaska, off the coast of Southern California and Hawaii, in the Mariana Islands, in Puget Sound, and off the coasts of Washington, Oregon, and California. During training, existing and established weapon systems and tactics are used in realistic situations to simulate and prepare for combat. Activities include: routine gunnery, missile, surface fire support, amphibious assault and landing, bombing, sinking, torpedo, tracking, and mine exercises. Testing activities are conducted for different purposes and include: at-sea research, development, evaluation, and experimentation. The Navy performs testing activities to ensure that its military forces have the latest technologies and techniques available to them. The majority of the training and testing activities the Navy conducts in the action area are similar, if not identical, to activities that have been occurring in the same locations for decades. SURTASS LFA sonar vessels may participate in joint major training events.

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

6.16.2.5 *Navy Active Sonar Routine Training, Testing, and Military Operations*

SURTASS LFA sonar is a coherent low frequency signal with a duty cycle of less than 20 percent, operating for a maximum of only 255 hours per year for each system (or 432 hours per year in the past) or a total of 10.6 days per year. This compares to an approximate 21.9 million days per year for the world’s shipping industry (presuming an 80 percent activity rate all the time). Thus, SURTASS LFA sonar transmissions would make up a very small part of the human-caused noise pollution in the ocean.

Previous and Ongoing MMPA Letters of Authorization for the Navy Active Sonar Operations

The information below is a summary of quarterly and annual mission reports provided by the Navy as a requirement of previous ESA section 7 consultations and MMPA Incidental Take Authorizations. Past operation of SURTASS LFA sonar in the western and central North Pacific Ocean over the 14 plus year period spanning from 2002 through the end of the August 2016 letter of authorization/incidental take statement reporting period involved 186 completed missions conducted in slightly over 576 days during which LFA sonar was transmitted for a total of 1,183 hours (Table 47). The Navy has not conducted SURTASS LFA sonar operations in other locations of the world. During those missions, 25 marine mammals or sea turtles were visually observed, eleven marine animals were detected passive acoustically, and 194 marine mammals/animals were detected active-acoustically by the HF/M3 active sonar system. These combined detections of marine animals led to 205 suspensions/delays of LFA sonar transmissions, per the mitigation protocol for the operation of SURTASS LFA sonar (see Table 47).

During the most recent full reporting period, which began on August 15, 2015 and was completed on August 14, 2016, 13 missions were conducted in the western North Pacific Ocean mission areas using four SURTASS LFA sonar systems. In total during the 2015 through 2016 reporting period, the Navy conducted 13 SURTASS LFA sonar missions over 31.1 days that resulted in a total LFA sonar transmission of 52.6 hours. Of the permitted 1,728 hours (432 hours per vessel) of LFA sonar transmit time for four SURTASS LFA sonar vessels, the Navy transmitted 3.04 percent of its permitted allocation. During the 52.6 hours of LFA sonar transmission, and in accordance with the mitigation monitoring protocol for SURTASS LFA sonar, LFA sonar was suspended or delayed 29 times during the 2015 through 2016 annual letter of authorization reporting period due to 28 active acoustic (HF/M3 sonar system), three passive acoustic, and nine visual detections of marine animals. No dead or injured marine animals were observed in conjunction with LFA sonar operations during the annual reporting period.

For the first two quarters of the current 2016 through 2017 reporting period, which commenced on August 15, 2016, three missions were conducted by two SURTASS LFA sonar vessels as of February 14, 2017 totaling 5.9 days and 16.5 hours of LFA sonar transmissions (Table 47). During the three LFA sonar missions, one visual detection, no passive acoustic detections, and four active acoustic detections of marine animals were reported within the mitigation and buffer zone. The one visual detection was identified as a whale fluke. Per mitigation protocol, LFA sonar transmissions were suspended or delayed five times due to the visual and active acoustic detections; LFA sonar transmissions were also suspended or delayed 58 times due to non-mitigation and monitoring factors and not due to detections of marine animals. No dead or injured marine animals were observed during any of the SURTASS LFA sonar operations to date in the 2016 to 2017 effective period.

During the August 2015 to August 2016 annual period, as has been the case throughout the history of SURTASS LFA sonar operations, no vessel strikes, physical injury, or strandings of marine mammals or sea turtles were observed, reported, or associated with the Navy's action. Both the historical and the most recent results (Table 47) of the mitigation and monitoring and effectiveness support the Navy's and NMFS' assertions that the Navy's three-part mitigation and monitoring protocols provide an effective means of avoiding risk of potential injury to protected marine species (see section 2.1.5).

Table 47. Summary of Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar missions and mitigation and monitoring measure detections from 2002 through February 14, 2017.

Year[1]	Vessel	Mission Summary			Visual Detections	Passive Acoustic Detections	Active Acoustic HF/M3 Detections	Non-Mitigation Protocol Suspensions/Delays[8]	Mitigation Protocol Suspensions/Delays
		Number	Days	LFA Sonar Hours					
2002 – 2003	R/V *Cory Chouest*	7	34.2	82.2	0	0	3	0	3
2003 – 2004	R/V *Cory Chouest*	5	72.5	173.7	0	0	10	0	10
	USNS *IMPECCABLE*	5			0	0	6	2	8
2004 – 2005	R/V *Cory Chouest*	3	22.5	41.9	0	0	1	11	12
	USNS *IMPECCABLE*	2			0	0	1	0	1
2005 – 2006	R/V *Cory Chouest*	12	95.6	173.2	1	0	47	10	58
	USNS *IMPECCABLE*	6			2	0	3	0	5
2006 – 2007	R/V *Cory Chouest*	6	94.6	161.5	0	0	30	50	80
	USNS *IMPECCABLE*	12			1	0	0	0	1
2007 – 2008	R/V *Cory Choest*	6	49.8	135.8	0	0	0	16	16
	USNS *IMPECCABLE*	8			1	0	19	7	27
2008 – 2009	USNS *ABLE*	3	23.7	32.5	1	0	1	3	5
	USNS *IMPECCABLE*	6			2	0	1	0	3
	USNS *ABLE*	10	17.1	43.6	0	0	0	0	0

2009 – 2010	USNS *IMPECCABLE*	21			1[3]	3[4]	3[4]	4	7
2010 – 2011	USNS *ABLE*	8	62.3	64.0	1[3]	1	1[3]	0	1
	USNS *EFFECTIVE*	1			2[5]	0	2[6]	1	4
	USNS *IMPECCABLE*	7			0	0	2	0	2
2-11 – 2012	USNS *EFFECTIVE*	5	28.5	66.3	0	0	0	0	0
	USNS *IMPECCABLE*	3			0	0	0	0	0
	USNS *VICTORIOUS*	1			0	0	0	0	0
2012 – 2013	USNS *ABLE*	3	24.4	47.3	0	0	0	0	0
	USNS *EFFECTIVE*	4			0	3	9	12	16
	USNS *IMPECCABLE*	2			0	0	0	0	12
	USNS *VICTORIOUS*	3			0	0	1	1	1
2013 – 2014	USNS *ABLE*	3	20.44	38.63	0	0	9	0	4
	USNS *EFFECTIVE*	3			0	0	9	0	0
	USNS *IMPECCABLE*	0			0	0	0	0	0
	USNS *VICTORIOUS*	1			0	0	1	0	1
2014 – 2015	USNS *ABLE*	1	22.9	51.6	0	0	1	2	0
	USNS *EFFECTIVE*	6			5	0	5	30	9
	USNS *IMPECCABLE*	2			1	0	1	23	1
	USNS *VICTORIOUS*	1			0	0	0	5	0
2015 – 2016	USNS *ABLE*	3	31.1	52.6	0	0	0	84	0
	USNS *EFFECTIVE*	6			5	3	21	46	21

	USNS *IMPECCABLE*	1			0	1	0	58	0
	USNS *VICTORIOUS*	3			4	0	7	24	8
2016 – 2017	USNS *ABLE*	2	5.92	16.54	0	0	1	25	1
	USNS *EFFECTIVE*	0			0	0	0	0	0
	USNS *IMPECCABLE*	1			1	0	3	33	4
	USNS *VICTORIOUS*	0			0	0	0	0	0
	Totals	185	576.16	1,182.59	28	11	190	447	329

[1] August through August
[3] Contact made when LFA sonar not transmitting
[4] Marine mammal passive contacts verified by HF/M3 sonar system
[5] One contact confirmed with HF/M3 sonar, second was a sea turtle
[6] Only one contact confirmed visually
[7] One visual sighting of a marine mammal after the mission ended and LFA sonar was non-operational
[8] Starting 2014, LFA sonar suspensions/delays for non-mitigation factors recorded.

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

Collectively, the stressors described above have had, and likely continue to have, lasting impacts on the ESA-listed species considered in this opinion. 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 the species considered in this opinion 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.

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

7 EFFECTS OF THE ACTION

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the ESA-listed species or designated 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 CFR §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. As discussed further in section 3.1, our effects analysis relies on the term "significant." The term "significant" means "clinically or biotically significant" rather than statistically significant because the presence or absence of statistical significance do not imply the presence or absence of clinical significance (Achinstein 2001; Royall 2004).

The ESA defines "take" as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct" 16 U.S.C. §1532(19). Harm is further defined by regulations to include "an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering" 50 CFR §222.102. 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 relied on this definition to evaluate whether the proposed activities are likely to harass ESA-listed sea turtle species.

For marine mammal species, NMFS' consultations with the Navy and NMFS (Permits and Conservation Division) regarding the effects of the Navy's SURTASS LFA sonar routine training, testing, and military operations and NMFS' promulgation of regulations and subsequent issuance of letters of authorization pursuant to the MMPA have long relied on outputs from AIM modeling to quantify instances of Level B harassment (behavior and TTS). The AIM model uses acoustic criteria to estimate the number of exposures and responses that could qualify as Level B harassment under the MMPA. The MMPA 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 not limited to, migration, breathing, nursing, breeding, feeding, or sheltering" [16 U.S.C. §1362(18)(A)]. For military readiness activities, this definition of "harassment" has been amended to mean, in part, "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behaviors are abandoned or significantly altered" [16 U.S.C. 1362(18)(B)]. NMFS has relied on the MMPA definition of Level B harassment in estimating the number of instances of harassment of ESA-listed marine mammals. The Navy requested initiation of formal consultation in October 2016, around the same time as issuance of the interim guidance. Further, data and information gathering for SURTASS LFA sonar operations modeling began prior to October 2016. Given this timing and the complexity associated with modeling take estimates of marine mammals, consistent with prior consultations for Navy SURTASS LFA sonar routine training, testing, and military operations, NMFS continues to rely on the MMPA definition of Level B harassment and the AIM model outputs to evaluate whether the proposed SURTASS LFA operations are likely to harass ESA-listed species and to estimate the number of instances of harassment of ESA-listed marine mammals considered in this opinion.

We note that as the definition of Level B harassment is currently applied, including in this consultation, a wide range of behavioral reactions may qualify as harassment, including but not limited to avoidance of the sound source, temporary changes in vocalizations or dive patterns, temporary avoidance of an area, or temporary disruption of feeding, migrating, or reproductive behaviors. The Navy modeled estimates calculated using the risk continuum function (described in section 3.1.1.1) do not differentiate between the types of potential behavioral reactions. Nor do the estimates provide information regarding the potential fitness or other biological consequences of the reactions on the affected individuals. We therefore consider the available scientific evidence to determine the likely nature of the modeled behavioral responses and the potential fitness consequences for affected individuals.

For all ESA-listed species considered in this consultation, the jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of an ESA-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 an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

In this section, we identify the potential stressors that are likely to have direct and indirect effect on the physical, chemical, and biotic environment of the action area. Then, we present our risk assessment regarding the potential for exposure, and effects from exposure, to SURTASS LFA sonar operations. We then describe the mitigation proposed to reduce the likelihood of exposure to ESA-listed species from those stressors. Our analysis assumes that these stressors pose no risk to ESA-listed species if these stressors do not co-occur with those species in space or time. We conclude by examining the likely responses of, and potential fitness consequences to, ESA-listed species given exposure to SURTASS LFA sonar operations.

The potential stressors (risks) to ESA-listed species that we analyzed from the proposed action are:

1. The vessels and vessel traffic associated with the proposed SURTASS LFA sonar activities;
2. The passive sonar components (SURTASS);
3. The active sonar components (LFA); and
4. The active sonar component of the monitoring/mitigation system (HF/M3).

During consultation, we made the final ESA determinations of effect for each of these stressors. Stressors that are not likely to adversely affect ESA-listed species or designated critical habitat are discussed in section 7.2. Stressors that are likely to adversely affect ESA-listed species or designated critical habitat are discussed in the exposure and response analysis.

7.1 Stressors that are Not Likely to Adversely Affect ESA-Listed Species

We determined that the following stressors are not likely to adversely affect ESA-listed species or designated critical habitat.

7.1.1 Vessel Operation

Operation of Navy vessels create potential stressors in the form of noise, discharges, and ship strikes. Below we discuss each of these stressors and the likelihood that they pose a risk to ESA-listed marine mammals and sea turtles.

7.1.1.1 *Noise*

Sounds emitted by large vessels (such as SURTASS LFA vessels) can be characterized as low-frequency, continuous, or tonal, and sound pressure levels at a source will vary according to speed, burden, capacity, and length (Kipple and Gabriele 2007; McKenna et al. 2012; Richardson et al. 1995b). Vessels ranging from 135 to 337 m (442.9 to 1,105.6 ft) generate peak source sound levels from 169 to 200 dB between 8 to 430 Hz. Source levels for 593 container ship transits were estimated from long-term acoustic recording received levels in the Santa Barbara shipping channel, and a simple transmission loss model using Automatic Identification System data for source-receiver range (McKenna et al. 2013b). Ship noise levels could vary 5 to 10 dB depending on transit conditions. Given the sound propagation of low frequency sounds, a large vessel in this sound range can be heard 139 to 463 km (75 to 250 nmi) away (Polefka 2004). Hatch et al. (2008) measured commercial ship underwater noise levels and reported average source level estimates (71 to 141 Hz) for individual vessels ranged from 158±2 dB (research vessel) to 186±2 dB (oil tanker).

Numerous studies of interactions between surface vessels and marine mammals have demonstrated that free-ranging marine mammals engage in avoidance behavior when surface vessels move toward them. It is not clear whether these responses are caused by the physical presence of a surface vessel, the underwater noise generated by the vessel, or an interaction between the two (Amaral and Carlson 2005; Au and Green 2000b; Bain et al. 2006; Bauer 1986; Bejder et al. 1999; Bejder and Lusseau. 2008; Bejder et al. 2009; Bryant et al. 1984; Corkeron 1995; Erbe 2002b; Felix 2001; Goodwin and Cotton 2004; Lemon et al. 2006; Lusseau 2003; Lusseau 2006; Magalhaes et al. 2002; Nowacek et al. 2001; Richter et al. 2003b; Scheidat et al. 2004; Simmonds 2005; Watkins 1986; Williams et al. 2002b; Wursig et al. 1998). However, several authors suggest that the noise generated during motion is probably an important factor (Blane and Jaakson 1994; Evans et al. 1992; Evans et al. 1994). These studies suggest that the behavioral responses of marine mammals to surface vessels are similar to their behavioral response to predators.

Based on the suite of studies of cetacean behavior to vessel approaches (Acevedo 1991; Aguilar Soto et al. 2006; Arcangeli and Crosti 2009; Au and Perryman 1982; Au and Green 2000b; Bain et al. 2006; Bauer and Herman 1986; Bejder et al. 1999; Bejder et al. 2006a; Bejder et al. 2006b; Bryant et al. 1984; Christiansen et al. 2010; Corkeron 1995; David 2002; Erbe 2002b; Felix 2001; Goodwin and Cotton 2004; Hewitt 1985; Lusseau 2003; Lusseau 2006; Magalhaes et al. 2002; Noren et al. 2009; Nowacek et al. 2001; Richter et al. 2006; Richter et al. 2003b; Scheidat et al. 2004; Simmonds 2005; Stensland and Berggren 2007; Stockin et al. 2008; Watkins 1986; Williams and Ashe 2007; Williams et al. 2009; Williams et al. 2002b; Wursig et al. 1998), the set of variables that help determine whether marine mammals are likely to be disturbed by surface vessels include:

- *The number of vessels*. The behavioral repertoire marine mammals have used to avoid interactions with surface vessels appears to depend on the number of vessels in their perceptual field (the area within which animals detect acoustic, visual, or other cues) and the animal's assessment of the risks associated with those vessels (the primary index of risk is probably vessel proximity relative to the animal's flight initiation distance (Sims et al. 2012). Below a threshold number of vessels (which varies from one species to another, although groups of marine mammals probably share sets of patterns), studies have shown that whales will attempt to avoid an interaction using horizontal avoidance behavior. Above that threshold, studies have shown that marine mammals will tend to avoid interactions using vertical avoidance behavior, although some marine mammals will combine horizontal avoidance behavior with vertical avoidance behavior (Bryant et al. 1984; Kruse 1991; Lusseau 2003; Nowacek et al. 2001; Stensland and Berggren 2007; Williams and Ashe 2007; Williams et al. 2002b);
- *The distance between vessel and marine mammals* when the animal perceives that an approach has started and during the course of the interaction (Au and Perryman 1982; Hewitt 1985; Kruse 1991; Lundquist et al. 2012; Lusseau 2003; Tseng et al. 2011; Williams et al. 2002b);
- *The vessel's speed and vector* (Williams et al. 2002b);

- *The predictability of the vessel's path*. That is, cetaceans are more likely to respond to approaching vessels when vessels stay on a single or predictable path (Acevedo 1991; Angradi et al. 1993; Browning and Harland. 1999; Lusseau 2003; Lusseau 2006; Williams et al. 2002a);
- *The noise associated with the vessel* (particularly engine noise) and the rate at which the engine noise increases (which the animal may treat as evidence of the vessel's speed) (Lusseau 2003; Lusseau 2006; Polagye et al. 2011; Williams et al. 2002b);
- *The type of vessel* (displacement versus planing), which marine mammals may be interpret as evidence of a vessel's maneuverability (Goodwin and Cotton 2004);
- *The behavioral state of the marine mammals* (Lusseau 2003; Lusseau 2006; Williams et al. 2002b; Wursig et al. 1998). For example, Würsig et al. (1998)concluded that whales were more likely to engage in avoidance responses when the whales were milling or resting than during other behavioral states (Wursig et al. 1998).

Most of the investigations reported that animals tended to reduce their visibility at the water's surface and move horizontally away from the source of disturbance or adopt erratic swimming strategies (Corkeron 1995; Lundquist et al. 2012; Lusseau 2003; Lusseau 2004; Nowacek et al. 2001; Van Parijs and Corkeron 2001; Williams et al. 2002a; Williams et al. 2002b). In the process, their dive times increased, vocalizations and jumping were reduced (with the exception of beaked whales), individuals in groups move closer together, swimming speeds increased, and their direction of travel took them away from the source of disturbance (Baker and Herman 1989; Edds and Macfarlane 1987; Evans et al. 1992; Kruse 1991). Some individuals also dove and remained motionless, waiting until the vessel moved past their location. Most animals finding themselves in confined spaces, such as shallows bays, during vessel approaches tended to move towards more open, deeper waters (Kruse 1991). We assume that this movement would give them greater opportunities to avoid or evade vessels as conditions warranted.

Although most of these studies focused on small cetaceans (for example bottlenose dolphins, spinner dolphins [*Stenella longirostris*], spotted dolphins [*Stenella* spp.], harbor porpoises (*Phocoena phocoena*), beluga whales [*Delphinapterus leucas*], and killer whales), studies of large whales have reported similar results for fin and sperm whales (Williams et al. 2002b). Baker et al. (1983) reported that humpbacks in Hawaii responded to vessels at distances of two to four km (1.1 to 2.2 nmi). Richardson et al. (1985a) reported that bowhead whales swam in the opposite direction of approaching seismic vessels at distances between one and four km (0.5 to 2.2 nmi) and engage in evasive behavior at distances under one km. Fin whales also responded to vessels at a distance of about one km (Edds and Macfarlane 1987). Würsig et al. (1998) studied the behavior of cetaceans in the northern Gulf of Mexico in response to survey vessels and aircraft. They reported that false killer whales either did not respond or approached the ship (most commonly to ride the bow). Four to 15 sperm whales avoided the ship while the remainder appeared to ignore its approach. A study by Lundquist (2012) on dusky dolphins (*Lagenorhynchus obscurus*) concluded that repeated disturbance from tour vessel traffic may interrupt social interactions, and postulated that those repeated disturbances from tour vessel traffic may interrupt social interactions, and that those repeated disturbances may carry energetic costs, or otherwise affect individual fitness. However, they were unable to determine if such disturbances were likely to cause long-term harm. For behavioral responses to result in energetic costs that result in long-term harm, such disturbances would likely need to be sustained for a significant duration or extent where individuals exposed would not be able to select alternate habitat to recover and feed. The operation of SURTASS LFA sonar vessels over large geographic areas would not likely result in such prolonged exposures and preclusion of individuals from feeding, breeding, or sheltering habitat.

We would expect similar behavioral avoidance responses, if any, from ESA-listed sea turtles and fish. Hazel et al. (2007) documented green sea turtle avoidance responses to oncoming vessels. The ESA-listed fish species considered in this opinion are highly mobile and, if present in proximity to SURTASS LFA sonar vessel, would be expected to temporarily move from the immediate area.

We recognize that SURTASS LFA sonar vessels almost certainly incorporate quieting technologies that reduce their acoustic signature (relative to the acoustic signature of similarly size vessels) in order to reduce their vulnerability to detection by enemy vessels (Southall 2005). Additionally, the slow ship speeds of SURTASS LFA sonar vessels result in very little engine or propeller cavitation noise being generated into the surrounding marine environment (Navy 2015). Nevertheless, we do not assume that any quieting technology or low travel speeds would be sufficient to prevent marine animals from detecting sounds produced by approaching U.S. Navy vessels and perceiving those sounds as predatory stimuli. We also consider evidence that factors other than received sound level, including the activity state of animals exposed to different sounds, the nature and novelty of a sound, and spatial relations between sound source and receiving animals (i.e., the exposure context) strongly affect the probability of a behavioral response (Ellison et al. 2012b).

We considered the research and reports cited above and conclude that ESA-listed marine mammals, sea turtles, and fish are likely to either not react or exhibit an avoidance behavior. Most avoidance responses would consist of slow movements away from vessels the animals perceive are on an approaching course, perhaps accompanied by slightly longer dives in marine mammals and sea turtles. Most of the changes in behavior would consist of a temporary shift from behavioral states that have low energy requirements (resting or milling) to behavioral states with higher energy requirements (active swimming or traveling) and then returning to the resting or milling behavior shortly thereafter.

Behavioral disruption of ESA-listed species resulting from the presence of vessels or submarines are expected to be temporary. Animals are expected to resume their migration, feeding, or other behaviors with no significant impact to their breeding, feeding, or sheltering. Marine mammals react to vessels in a variety of ways and seem to be generally influenced by the activity the marine mammal is engaged in when a vessel approaches (Richardson et al. 1995e). Some respond negatively by retreating or engaging in antagonistic responses while other animals ignore the stimulus altogether (Terhune and Verboom 1999; Watkins 1986). Given the short duration of vessel noise stressors, the infrequency of this stressor, and the temporary nature of biological responses of marine mammals, sea turtles, and fish to this stressor, these ESA-listed species are either not likely to respond or are not likely to respond in ways that might be adverse (the response might represent an approach or attentive movement, a small change in orientation in the waters, etc.).

In conclusion, ESA-listed species are either not likely to respond to vessel noise or are not likely to measurably respond in ways that would significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Therefore, the effects of noise from Navy vessels conducting SURTASS LFA sonar activities on ESA-listed species is considered insignificant and is not likely to adversely affect ESA-listed species. The potential effects of vessel noise will not be considered further in this opinion.

7.1.1.2 *Discharges*

Operation of the SURTASS LFA sonar vessels will result in discharges incidental to normal operations of a vessel. The International Convention for the Prevention of Pollution from Ships (MARPOL73/78) prohibits certain discharges of oil, noxious liquid substances, sewage, garbage, and air pollution from vessels within certain distances of the coastline. The Convention is implemented by the Act to Prevent Pollution from Ships (APPS; 33 U.S.C. §§1905-1915 et seq.), which establishes requirements for the operation of Navy vessels. The SURTASS LFA sonar vessels will operate in compliance with these requirements. Despite the precautionary measures taken by the Navy to ensure such incidents do not occur, it is possible for an unintentional and intentional discharge of pollutants to occur. While such discharges may affect certain water quality properties, trigger harmful algal blooms, and temporarily affect distributions and behaviors of ESA-listed species and their prey, the size, duration, and localized extent of such discharges from only four vessels, would likely be minor relative to the vast action area. Additionally, the Navy has instituted a “double-exchange” policy for surface vessel ballast tanks. All Navy surface vessels completely offload ballast water originating in a foreign port outside of 22 km (12 nmi) from shore and take on and discharge ‘clean sea water’ two times prior to entry within 22 km (12 nmi) of shore. The seawater then can be discharged within 22 km (12 nmi) of shore whenever ballast is no longer needed (E.P.A. 1999). This minimizes the likelihood that ballast water from SURTASS LFA sonar vessels will transfer invasive species. Therefore, we also evaluated the potential for a small pollutant discharge that could occur during project activities to impact ESA-listed species. However, because of the open ocean environment in which the proposed action will occur, the duration and small spatial extent of such a spill, and the wide-ranging life histories and mobility of ESA-listed species that may occur in the action area, the effects of a small spill are considered insignificant. As a result, discharges incidental to normal operations of a vessel are not likely to adversely affect ESA-listed species and will not be considered further in this opinion.

7.1.1.3 *Ship Strike*

Potential adverse effects to ESA-listed species could occur through ship strikes. However, during the 15 years (2002 through 2017) of MMPA incidental take authorizations and ESA section 7 consultations for SURTASS LFA sonar vessel operations, there have not been any ship strikes of a marine animal (i.e., marine mammal, sea turtle, or fish) (Navy 2016). The slow speed of travel, the design of the T-AGOS vessels, with the catamaran-type split hull shape, and enclosed propeller system, make the potential for ship strike unlikely. Further, since the visual observers that keep watch during routine vessel transit and maneuvering are also trained in the detection of marine mammals and sea turtles, the likelihood is increased that any marine mammal or sea turtle in the vessel's path during daylight hours would be detected. During SURTASS LFA sonar operations, the combination of slow (3 knots; 3.5 kph during sonar operations and 10 knots; 11.5 kph during transit) ship speeds and the three elements of the Navy's monitoring and mitigation program are expected to virtually eliminate the risk of ship strikes of cetaceans. For these reasons, we conclude that the likelihood of a SURTASS LFA sonar vessel striking a cetacean is so low as to be discountable.

ESA-listed pinnipeds, sea turtles, and fish may also be vulnerable to ship strike (Brown and Murphy 2010; Hazel et al. 2007). However, because of: (1) the slow speed of the SURTASS LFA sonar vessels (3 knots; 3.5 kph during sonar operations and 10 knots; 11.5 kph during transit) and the ability of these species to move out of the way of such vessels; (2) the low densities of these species in the offshore areas where the vessels would be maneuvering; and (3) the Navy's monitoring and mitigation program, we also conclude that the likelihood of a SURTASS LFA sonar vessel striking an ESA-listed pinniped, fish, or sea turtle is so low as to be discountable. Because the likelihood of a vessel strike is so low as to be discountable, vessel strike is not likely to adversely affect the ESA-listed species considered in this opinion and this potential stressor will not be discussed further.

7.1.2 Passive Sonar Components

The passive, or listening, part of the SURTASS LFA sonar system is the SURTASS. This system detects returning echoes from submerged objects, such as threat submarines, through the use of hydrophones. Part of the SURTASS transforms mechanical energy (received acoustic sound wave) to an electrical signal that can be analyzed by the processing system of the sonar. The SURTASS hydrophones are mounted on a receiver array (horizontal line array) that is towed astern of the vessel. The SURTASS LFA sonar vessel tows the hydrophone array at a minimum speed of 5.6 kph (3 knots) through the water to maintain the proper towed array geometry for maximum sonar system performance. The return signals, which are usually below background or ambient noise level, are then processed and evaluated to identify and classify potential underwater threats. The slow tow speed of the SURTASS LFA sonar vessel would provide sufficient time for a marine animal to move and avoid the SURTASS component if it were in close proximity, and it is unlikely that individuals would become struck or entangled. During the 15 years of MMPA Incidental Take Authorizations and ESA section 7 consultations for

SURTASS LFA sonar operations, there have not been any ESA-listed species struck or entangled in the deployed equipment (C.Schroeder on behalf of the Navy, personal communication, February 13, 2017) (Navy 2016). For these reasons, the likelihood of passive sonar components striking or becoming entangled with an ESA-listed species is discountable. Because this sonar system does not transmit energy into the marine environment and the likelihood of passive sonar components striking or entangling an ESA-listed species is discountable, we conclude that passive sonar components are not likely to adversely affect ESA-listed species in the action area. Therefore, the effect of this potential stressor is insignificant and will not be discussed further in this opinion.

7.1.3 High Frequency/Marine Mammal Monitoring Sonar

As a mitigation measure to reduce the exposure of marine mammals and sea turtles to SURTASS LFA sonar, the Navy will operate the HF/M3 sonar continuously during the course of active sonar transmissions. The HF/M3 sonar is a Navy-developed, enhanced high-frequency commercial sonar designed to detect, locate, and track marine mammals and, to some extent, sea turtles and large fish (e.g., sharks, sturgeon) that may pass close enough to the SURTASS LFA sonar's transmitter array to enter the LFA sonar mitigation and buffer zones. Analysis and testing of the HF/M3 sonar operating capabilities indicate that the system substantially increases the probability of detecting marine mammals within the LFA sonar mitigation and buffer zones, and beyond (i.e., out to 2 to 2.5 km). Testing of the HF/M3 sonar has demonstrated a probability of single-ping detection above 95 percent within the LFA sonar mitigation and buffer zones for many marine mammals (Ellison and Stein 1999).

The source level required for the HF/M3 sonar to effectively detect marine mammals (and possibly sea turtles) out to the 180-dB LFA sonar mitigation and buffer zones under the most adverse oceanographic conditions (low echo return and high ambient noise) is on the order of 220 dB re: 1 µPa (rms) at 1 m. The Navy designed the HF/M3 sonar to be as benign as possible within the marine environment to minimize potential effects to marine mammals and sea turtles. These features include:

1. The HF/M3 sonar source frequency is greater than 30 kHz, which pushes its frequency band well away from the best hearing bandwidth of mysticetes, pinnipeds, and sea turtles, but within the best hearing bandwidth of odontocetes;
2. A duty cycle that is variable, but below ten percent;
3. A maximum HF/M3 sonar pulse with a duration of 40 milliseconds. Ridgway et al. (1997) and Schlundt et al. (2000b) reported that measured TTS in bottlenose dolphins for a 20 kHz, one-second pulse occurred at received levels of 193 to 196 dB. For a 30 kHz, 40-milliseconds pulse, the estimated range from the HF/M3 sonar of 193 dB received level would be 22 m (72 ft); and
4. A transmission loss that is very high because of the high frequency of the sound source.

With the exception of odontocetes, we do not expect most ESA-listed species will be able to detect and potentially respond to HF/M3, if exposed. For these species, the effect of potential exposure to HF/M3 is insignificant. As an additional safety measure for odontocetes, HF/M3 sonar source level would be ramped-up over a five minute period to alert any animals that are close to the sonar and provide them time to move away from the sound source. This would prevent the animal from being exposed to sound levels that could cause injury. Behavioral disruptions of individuals resulting from exposure to HF/M3 sonar during ramp up that could cause the animal to move away from the sound source are expected to be temporary and insignificant. Given the short duration of potential exposure, the infrequency of this stressor, and the temporary nature of biological responses of marine mammals, ESA-listed species evaluated in this consultation are either not likely to respond or are not likely to respond in ways that could be of biological significance. Therefore, the potential effect of HF/M3 sonar on ESA-listed species is considered insignificant, is not likely to adversely affect ESA-listed species, and will not be considered further in this opinion.

7.2 Stressors that are Likely to Adversely Affect Endangered Species Act-Listed Species

The remaining stressor to evaluate is the active sonar component – LFA sonar. Here we consider the effects of LFA sonar on ESA-listed marine mammals and sea turtles by first describing the active sonar components, identifying the potential effects to ESA-listed marine mammals and sea turtles, assessing the exposure of ESA-listed marine mammals and sea turtles to LFA sonar, then discussion the likely responses and finally the overall risk to the ESA-listed marine mammals and sea turtles.

7.2.1 Active Sonar Components

The LFA system consists of up to 18 low-frequency acoustic-transmitting projectors that are suspended from a cable beneath the ship. The source level of an individual projector in the LFA sonar array is about 215 dB re: 1 µPa (rms) at 1 m, and the sound field of the array can never have a sound pressure level higher than that of an individual projector. The typical LFA sonar signal is not a constant tone, but is a transmission of various signal types that vary in frequency and duration (including continuous wave and frequency-modulated signals). The Navy refers to a complete sequence of sound transmissions as a “ping” which can range from between six and 100 seconds, with no more than ten seconds at any single frequency. The time between pings will typically range from six to 15 minutes. The Navy can control the average duty cycle (the ratio of sound “on” time to total time) for the system but the duty cycle cannot exceed 20 percent. Based on operations since 2003, the duty cycle has averaged about 7.5 percent.

The LFA sonar mitigation zone covers a volume ensonified to a received level at or above 180 dB re: 1 µPa (rms) by the SURTASS LFA sonar transmit array. Based on spherical spreading, this zone will vary between the nominal ranges of 0.75 to one km (0.4 to 0.5 nmi) from the source array ranging over a depth of approximately 87 to 157 m (285 to 515 ft). The center of the array is at an approximate depth of 122 m (400 ft).

We assume that the propagation of signals transmitted from LFA sonar systems would be affected by surface ducts, sound channels, convergence zones, and bottom interactions. For more complete discussion of sound propagation in marine environments, readers should refer to Richardson et al. (1995e), Appendix B of the Navy EIS on SURTASS LFA sonar (Navy 2001b), and NMFS' 2002 and 2007 MMPA final rule and biological opinions on SURTASS LFA sonar.

Section 7.6 presents our exposure and response analyses for this stressor.

7.3 Risk Assessment Framework – Marine Mammals

For marine mammals that are exposed to SURTASS LFA sonar transmission, this section examines the relationship between received levels and ecological effects; the plausibility of adverse effects occurring as a result of exposure; and linkages between measurable ecological effects and vital rates or biologically-important behavior in populations of ESA-listed marine mammals, which are the endpoints for this assessment. In this analysis we consider potential for non-auditory injury, auditory injury (PTS), TTS, behavioral changes, masking, and stranding as a result of exposure to SURTASS LFA sonar.

To assess the plausibility of adverse effects resulting from exposure to SURTASS LFA sonar, we evaluated various lines of evidence from published and unpublished sources on the effects of SURTASS LFA sonar on threatened and endangered species, other studies of low frequency sound, and reports on the effects of other sonars. We evaluate the same lines of evidence to establish linkages between the potential effects of SURTASS LFA sonar on biologically important behavior of ESA-listed species exposed to the sonar. We also consider information provided in annual and summary reports on previous SURTASS LFA sonar operations.

7.3.1 Non-Auditory Injury

Potential non-auditory injury to marine mammals from LFA sonar is unlikely due to relatively lower peak pressures and slower rise times than potentially injurious impulsive sources such as explosives. Non-impulsive sources also lack the strong shock waves associated with explosions. Therefore, primary blast injury and barotrauma (i.e., injuries caused by large pressure changes) will not occur from exposure to LFA sonar. Further, though there have been marine mammal strandings associated with use of sonar, as Ketten (2012) has summarizes, “to date, there has been no demonstrable evidence of acute, traumatic, disruptive, or profound auditory damage in any marine mammal as the result [of] anthropogenic noise exposures, including sonar.” The theories of sonar induced acoustic resonance, sonar induced bubble formation, and nitrogen decompression are discussed below. These phenomena, if they were to occur, would require the co-occurrence of a precise set of circumstances that are unlikely to occur.

7.3.1.1 *Acoustic Resonance*

Physical effects, such as direct acoustic trauma or acoustically enhanced bubble growth, require relatively intense received energy that would only occur at short distances from high-powered sonar sources (Nowacek et al. 2007; Zimmer and Tyack 2007). The best available scientific information shows that, while resonance can occur in marine animals, this resonance does not necessarily cause injury, and any such injury is not expected to occur below a received level of

180 dB SPL. Damage to the lungs and large sinus cavities of cetaceans from air space resonance is not likely to occur because resonance frequencies of marine mammal lungs are below that of the LFA sonar signal (Finneran 2003). Further biological tissues are heavily damped and tissue displacement at resonance is predicted to be exceedingly small. In addition, lung tissue damage is generally uncommon in acoustic-related standings (Southall et al. 2007).

7.3.1.2 *Bubble Formation*

A suggested cause of injury to marine mammals is rectified diffusion (Crum and Mao 1996), the process of increasing the size of a bubble by exposing it to a sound field. The process is dependent upon a number of factors including the sound pressure level and duration. Under this hypothesis, one of three things could happen: (1) bubbles grow to the extent that tissue hemorrhage (injury) occurs, (2) bubbles develop to the extent an immune response is triggered for nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury), or (3) the bubbles are cleared by the lung without negative consequence to the animal. The probability of rectified diffusion, or any other indirect tissue effect, will necessarily be based upon what is known about the specific process involved. Rectified diffusion is more likely if the environment in which the ensonified bubbles exist is supersaturated with gas. Repetitive diving by marine mammals can cause the blood and some tissues to accumulate gas to a greater degree than is supported by the surrounding environmental pressure (Ridgway and Howard 1979). The dive patterns of some marine mammals (e.g., beaked whales) are theoretically predicted to induce greater supersaturation (Houser 2010; Houser et al. 2001c). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate of bubble growth and increase the size of the bubbles. Subsequent effects due to tissue trauma and emboli would presumable mirror those observed in humans suffering from decompression sickness. It is unlikely the short duration of sonar would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs.

An alternative but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through statis diffusion of gas out of the tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for enough time for bubbles to become a problematic size. Recent research with *ex vivo* supersaturated bovine tissues suggested that for a 37 kHz signal, a sound exposure of approximately 215 dB re: 1 µPa would be required before microbubbles became destabilized and grew (Crum et al. 2005). Assuming spherical spreading loss and a nominal sonar source level of 235 dB re: 1 µPa at 1 m, a whale would need to be within 10 m (33 ft) of the sonar dome to be exposed to such sound levels (which is highly unlikely to occur given the mitigation measures in place). Furthermore, tissues in the study were supersaturated by exposing them to pressures of 400 to 700 kilopascals for hours and then releasing them to ambient pressures. Assuming the equilibration of gases with the tissues occurred when the tissues were exposed to the high pressures, levels of supersaturation in the tissues could have been as high as

400 to 700 percent. These levels of tissue supersaturation are substantially higher than model predictions for marine mammals (Houser et al. 2001a; Saunders et al. 2008b). It is improbable this mechanism is responsible for stranding events or traumas associated with beaked whale strandings (which are not listed under the ESA). Both the degree of supersaturation and exposure levels observed to cause microbubble destabilization are unlikely to occur.

There is considerable disagreement among scientists as to the likelihood of this phenomenon (Evans and Miller 2004; Piantadosi and Thalmann 2004). Although it has been argued that traumas from recent beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Fernandez et al. 2005a; Jepson et al. 2003), bubble formation as the cause of the traumas has not been verified. The presence of bubbles post-mortem, particularly after decompression, is not necessarily indicative of bubble pathology (Bernaldo de Quiros et al. 2012; Dennison et al. 2011; Moore et al. 2009). Prior experimental work has also demonstrated the post-mortem presence of bubble following decompression in laboratory animals can occur as a result of invasive investigative procedures (Stock et al. 1980).

Despite the increase in research and literature, there remains scientific disagreement and a lack of scientific data regarding the evidence for gas bubble formation as a causal mechanism between certain types of acoustic exposures and stranding events in marine mammals. These issues include: (1) received acoustic exposure conditions; (2) pathological interpretation; (3) acoustic exposure conditions required to directly induce physiological trauma; (4) behavioral reactions caused by sound exposure such as atypical dive patterns; and (5) the extent of post-mortem artifacts (Southall et al. 2007).

The hypotheses for gas bubble formation related to beaked whale strandings is that beaked whales potentially have strong avoidance responses to mid-frequency active (MFA) sonars because they sound similar to their main predator, the killer whale (Baird et al. 2008; Cox et al. 2006; Hooker et al. 2009b; Southall et al. 2007; Zimmer and Tyack 2007). Because SURTASS LFA sonar transmissions are lower in frequency (less than 500 Hz) and dissimilar in characteristics from those of marine mammal predators, the above scientific studies do not provide evidence that SURTASS LFA sonar has caused behavioral reactions, specifically avoidance responses, in beaked whales. Thus, SURTASS LFA sonar transmissions are not expected to cause gas bubble formation or marine mammal strandings.

7.3.1.3 *Nitrogen Decompression*

Although not a direct injury, variations in marine mammal diving behavior or avoidance responses could result in nitrogen tissue supersaturation and nitrogen off-gassing. Nitrogen supersaturation and off-gassing levels could result in deleterious vascular and tissue bubble formation (Hooker et al. 2012; Jepson et al. 2003; Saunders et al. 2008a). Nitrogen off-gassing occurring in human divers is called decompressions sickness. The mechanism for bubble formation from saturated tissues would be indirect and also different from rectified diffusion, but the effects would be similar. The potential process for this to occur is hypothetical and under debate in the scientific community (Hooker et al. 2012; Saunders et al. 2008b). It is speculated if exposure to a startling sound elicits a rapid ascent to the surface, tissue gas saturation sufficient for the evolution of nitrogen bubbles might result (Fernandez et al. 2005a; Hooker et al. 2012; Jepson et al. 2003). In this scenario, the rate of ascent would need to be sufficiently rapid to compromise behavioral or physiological protections against nitrogen bubble formation. Fahlman et al. (2009) suggested that repeated dives might result in tissue and blood levels of nitrogen sufficient to cause symptomatic bubble formation.

Previous modeling suggests even unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent bubble formation would be expected in beaked whales (Zimmer and Tyack 2007). Tyack et al. (2006) suggested emboli observed in animals exposed to MFA sonar (Fernandez et al. 2005a; Jepson et al. 2003) could stem from a behavioral response that involves repeated dives, shallower than the depth at which lung collapse would occur. A bottlenose dolphin was trained to repetitively dive to elevate nitrogen saturation to the point that asymptomatic nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of any nitrogen gas bubbles (Houser 2010).

More recently, modeling has suggested that the long, deep dives performed regularly by beaked whales over a lifetime could result in the saturation of tissues (e.g., fat, bone lipid) to the point that they are supersaturated when the animals are at the surface (Hooker et al. 2009a; Saunders et al. 2008b). Proposed adaptations for prevention of bubble formation under conditions of persistent issue saturation have bene suggested (Fahlman et al. 2006; Hooker et al. 2009a). Since bubble formation is facilitated by compromised blood flow, it has been suggested that rapid stranding may lead to bubble formation in animals with supersaturated tissues because of the stress of stranding and the cardiovascular collapse that can accompany it (Houser 2010).

A fat embolic syndrome was identified by Fernandez et al. (2005b) coincident with the identification of bubble emboli in stranded beaked whales. The fat embolic syndrome was the first pathology of this type identified in marine mammals, and was thought to possible arise from the formation of bubbles in fat bodies, which subsequently resulted in the release of fat emboli into the blood stream. Recently, Dennison et al. (2011) reported on investigations of dolphins stranded in 2009 and 2010. Using ultrasound, the authors identified gas bubbles in kidneys from 21 of 22 live-stranded dolphins and in the liver from two of 22. The authors postulated stranded animals are unable to recompress by diving, and thus may retain bubbles that are otherwise re-absorbed in animals that can continue to dive. The researchers concluded minor bubble formation can be tolerated since the majority of stranded dolphins released did not re-strand (Dennison et al. 2011). Recent modeling by Kvadsheim (2012) determined behavioral and physiological responses to sonar have the potential to result in bubble formation. However, the observed behavioral responses of cetaceans to sonar do not imply any significantly increased risk over what may otherwise occur normally in individual marine mammals. As a result, no marine mammals addressed in this analysis are given differential treatment due to the possibility for acoustically mediated bubble growth.

7.3.2 Hearing Loss – Permanent Threshold Shift and Temporary Threshold Shift

The most familiar effect of exposure of high intensity sound is hearing loss, meaning an increase in the hearing threshold. The meaning of the term "hearing loss" does not equate to "deafness." This phenomenon is called a noise-induced threshold shift, or simply a threshold shift. If high-intensity sound over stimulates tissues in the ear, causing a threshold shift, the impacted area of the ear (associated with and limited by the sound's frequency band) no longer provides the same auditory impulses to the brain as before the exposure (Ketten 2012). The distinction between PTS and TTS is based on whether there is a complete recovery of a threshold shift following a sound exposure. If the threshold shift eventually returns to a zero (the threshold returns to the pre-exposure value), the threshold shift is a TTS. TTS may last from minutes to days. The following physiological mechanisms may result in TTS:

1. Reduced sensitivity of the sensory hair cells in the inner ear as a result of their being over-stimulated;
2. Modification of the chemical environment within sensory cells;
3. Displacement of certain inner ear membranes;
4. Increased blood flow; and
5. Post-stimulation reduction in both efferent (impulses traveling from the central nervous system to the peripheral sensory tissue) and sensory output (Kryter 1994; Southall et al. 2007).

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 amount 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). In some cases, threshold shifts as large as 50 dB (loss in sensitivity) have been temporary, although recovery sometimes required as much as 30 days (Ketten 2012). If the threshold shift does not return to zero but leaves some finite amount of threshold shift, then that remaining threshold shift is a PTS. Figure 65 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS. The actual amount of threshold shift depends on the amplitude, duration, frequency, temporal pattern of the sound exposure, and on the susceptibility of the individual animal.

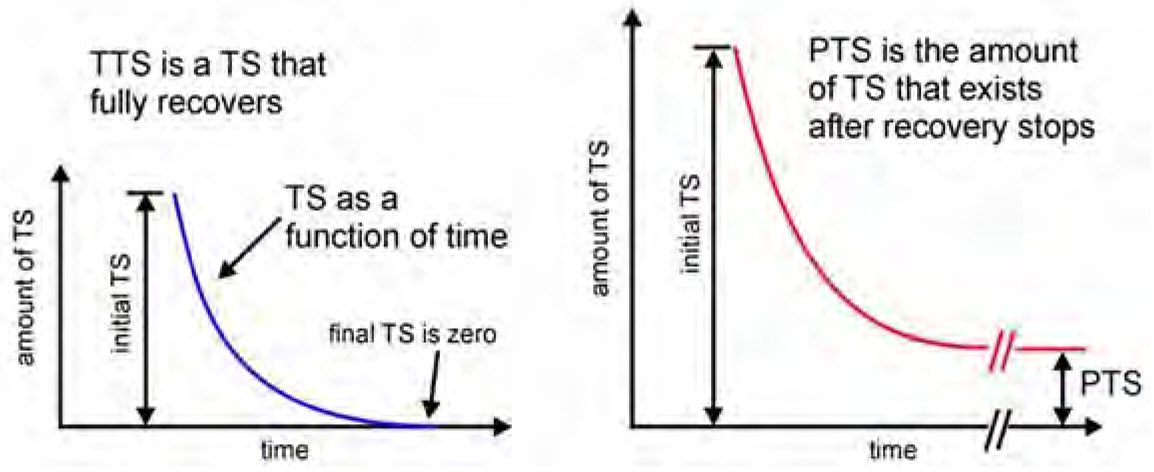

Figure 65. Two Hypothetical Threshold Shifts, Temporary and Permanent.

Both auditory trauma and auditory fatigue may result in hearing loss. Many are familiar with hearing protection devices (i.e., ear plugs) required in many occupation settings where persistent noise could otherwise cause auditory fatigue and possibly result in hearing loss. The mechanisms responsible for auditory fatigue differ from auditory trauma and would primarily consist of metabolic fatigue and exhaustion of the hair cells and cochlear tissues. Note that the term “auditory fatigue” is often used to mean “temporary threshold shift;” however, we use a more general meaning to differentiate fatigue mechanism (e.g., metabolic exhaustion and distortion of tissues) from trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure). The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal pattern of the sound exposure.

Hearing loss in marine mammals has been studies by a number of investigators (Finneran et al. 2005; Finneran and Schlundt 2010; Finneran et al. 2007; Finneran et al. 2000b; Finneran et al. 2002b; Lucke et al. 2009; Mooney et al. 2009a; Mooney et al. 2009b; Nachtigall et al. 2003; Schlundt et al. 2000a). The studies of marine mammal auditory fatigue were all designed to determine relationships between TTS and exposure parameters such as level, duration, and frequency.

In these studies, hearing thresholds were measured in trained marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds indicated the amount of TTS. Species studied include the bottlenose dolphin (*Tursiops truncatus*) (total of nine individuals), beluga whale (two), harbor porpoise (one), finless porpoise (*Neophocaena phocaenoides*) (two), California sea lion (*Zalophus californianus*) (three), harbor seal (one), and Northern elephant seal (one). Some of the more important data obtained from these studies are onset-TTS levels – exposure levels sufficient to cause a just-measurable amount of TTS, often defined as six dB of TTS (Schlundt et al. 2000a). These criteria for onset-TTS are very conservative, and it is not clear that this level of threshold shift would have a functional effect on the hearing of a marine mammal in the ocean.

Some of the primary findings of the marine mammal TTS studies are:

- The growth and recovery of TTS are analogous to those in terrestrial mammals. This means that, as in terrestrial mammals, threshold shifts primarily depend on the amplitude, duration, frequency, content, and temporal pattern of the sound exposure.
- The amount of TTS increases with exposure sound pressure level and the exposure duration.
- For continuous sounds, exposures of equal energy lead to approximately equal effects (Ward 1997). For intermittent sounds, less hearing loss occurs than from a continuous exposure with the same energy (some recovery will occur during the quiet period between exposures) (Kryter et al. 1965; Ward 1997).
- Sound exposure level is correlated with the amount of TTS and is a good predictor for onset-TTS from single, continuous exposures with similar durations. This agrees with human TTS data presented by Ward et al. (Ward et al. 1958; Ward et al. 1959a; Ward et al. 1959b). However, for longer duration sounds – beyond 16 to 32 seconds, the relationship between TTS and sound exposure level breaks down and duration becomes a more important contributor to TTS (Finneran and Schlundt 2010). Still, for a wide range of exposure durations, sound exposure level correlates reasonably well to TTS growth (Popov et al. 2014).
- The maximum TTS after tonal exposures occurs one-half to one octave above the exposure frequency (Finneran et al. 2007; Schlundt et al. 2000a). TTS from tonal exposures can thus extend over a large (greater than one octave) frequency range.
- For bottlenose dolphins, sounds with frequencies above 10 kHz are more hazardous than those at lower frequencies (i.e., lower sound exposure levels required to affect hearing) (Finneran and Schlundt 2010; Finneran and Schlundt 2013).
- The amount of observed TTS tends to decrease with increasing time following the exposure; however, the relationship is not monotonic. The amount of time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts recovery may be complete in a few minutes, while large shifts (e.g., 40 dB) require several days for recovery.
- TTS can accumulate across multiple intermittent exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same sound exposure level. This means that predictions based on total, cumulative, sound exposure level will overestimate the amount of TTS from intermittent exposures.

A study of TTS in harbor porpoises used a seismic airgun as a stimulus (Lucke et al. 2009). Airguns produce an impulsive signal and have a broad frequency range but also have substantial energy in the low frequency region. A small airgun was used in proximity to the animals (between 14 to 150 m [46 to 492 ft]), a context that is likely to enhance behavioral responsiveness. The harbor porpoises showed a behavioral response at a received level of 174 dB re: 1 µPa (peak-to-peak), which is equivalent to a sound exposure level of 145 dB re: 1 µPa^2-sec

(Lucke et al. 2009). Harbor porpoise hearing was tested at a frequency of 4 kHz and TTS was detected at a received level of 199.7 dB re: 1 µPa (peak-to-peak), which is equivalent to a sound exposure level of 164.3 dB re: 1 µPa^2-sec (Lucke et al. 2009). These data are intriguing and clearly indicate a need for additional research. Unfortunately, only one individual was tested in this study. The applicability of these results to SURTASS LFA sonar is uncertain, given the large differences in source characteristics between airguns and LFA sonar. Nevertheless, this study indicates that further study of TTS in porpoises is warranted. Ideally, additional harbor porpoise individuals as well as additional high-frequency hearing species would be tested. If this type of results are confirmed for harbor porpoise or found in other high-frequency species, then the analyses for those species would merit revision.

In a study on the effects of noise level and duration of TTS in a bottlenose dolphin, Mooney et al. (2009a) exposed a bottlenose dolphin to octave-band noise (four to eight kHz) of varying durations (two to 30 minutes) and sound pressure level received levels (130 to 178 dB re: 1 µPa). The results of the Mooney et al. study indicated that shorter-duration sound exposures often require greater sound energy to induce TTS than longer-duration exposures and also supported the trend that longer duration exposures often induce greater amounts of TTS, which concurrently require longer recovery times.

In a controlled exposure experiment, Mooney et al. (2009b) demonstrated that MFA sonar could induce temporary hearing loss in a bottlenose dolphin. Temporary hearing loss was induced by repeated exposure to a sound exposure level of 214 dB re: 1 µPa^2-sec. Subtle behavioral alterations were also associated with the sonar exposures. At least with one odontocete species (common bottlenose dolphin) sonar can induce both TTS and mild behavioral effects; but exposures must be prolonged with high exposure levels to generate these effects. The received level used in the Mooney et al. (2009b) experiment was a sound pressure level of 203 dB, which equates to the received level approximately 40 m (131 ft) from an MFA sonar operated at a sound pressure level of 235 dB (source level). Mooney et al. (2009b) concluded that in order to receive a sound exposure level of near 214 dB, an animal would have to remain in proximity of the moving sonar, which is transmitting for 0.5 seconds every 24 seconds, over an approximately two to 2.5 minute period, an unlikely situation.

Sound exposure levels necessary for TTS onset for pinnipeds in water have been measured for harbor seals, California sea lions, and Northern elephant seals. As reported by Southall et al. (2007), Kastak et al. (2005) presented comparative analysis of underwater TTS for pinnipeds. This indicated that in harbor seals, a TTS of approximately six dB occurred with a 25-minute exposure to 2.5 kHz octave-band noise of 152 dB sound pressure level (183 dB sound exposure level); a California sea lion showed TTS-onset under the same conditions at 174 dB sound pressure level (206 dB sound exposure level); and a Northern elephant seal under the same conditions experienced TTS-onset at 172 dB sound pressure level (204 dB sound exposure level). Finneran et al. (2003) exposed two California sea lions to single underwater pulses from an arc-gap transducer and found no measurable TTS following exposures of up to 183 dB sound pressure level (215 dB sound exposure level).

Animals suffering from TTS over longer periods of time, such as days, may be considered to have a change in a biologically significant behavior, as they may be prevented from detecting sounds that are biologically relevant, including communication sounds, sounds of prey, or sounds of predators. As noted by Mooney et al. (2009a), shorter duration sound exposures can require greater sound energy to induce TTS than longer duration exposures, and longer duration exposures can induce greater amounts of TTS. In assessing the potential for LFA sonar transmissions to cause TTS, the much shorter length of the LFA sonar signal (typically one minute) versus the above studies (two to 30 minutes) must be considered.

In a recent synthesis of TTS experiments and information, Tougaard et al. (2014) report that although TTS by definition is considered a temporary effect, recent experiments with terrestrial mammals suggest that an animal’s auditory system may not recover fully from severe TTS and that permanent denigration of the cochlear nerve system may result from recoverable TTS episodes and possibly repeated severe TTS can cause accumulated damage that could lead to a neurologically-based PTS. Additionally, the authors reported on the potential for earlier TTS studies to have overestimated the levels for onset of TTS due to high levels of ambient noise in the experimental setting as well as the use of older animals without optimal hearing (Tougaard et al. 2014). While other recent research has shown that harbor and finless porpoises are more sensitive to sound than expected from extrapolations of research results on bottlenose dolphins (Schlundt et al. 2000a), Tougaard et al. (2014) caution that it is not known whether these results were due to differences in experimental methodology, masking levels, or the age and health of the subject animals, but the reliability of extrapolating TTS thresholds between species relies on careful examination of such factors.

TTS studies of harbor porpoises have indicated a higher susceptibility to noise than other odontocetes and more sensitivity to sound than expected from extrapolations based on results from bottlenose dolphins and belugas (Kastelein et al. 2012; Kastelein et al. 2014a; Lucke et al. 2009). Kastelein et al. (2014a) induced up to about 30 dB re: 1 µPa^2-sec (SEL) of TTS by exposure of an eight-year old harbor porpoise to frequency modulated sweeps between one and two kHz (without harmonics) in various combinations of duration (1.9 to 240 minutes), intensity (144 to 179 dB re: 1 µPa SPL), and duty cycle (five to 100 percent), with SEL thresholds for TTS occurring between 188 and 196 dB re: 1 µPa^2-sec. Additionally, Kastelein et al. (2014a) found that the inter-pulse interval of the experimental sound was an important parameter in determining the magnitude of noise-induced TTS.

In a separate study, Kastelein et al. (2014b) determined the effects on the hearing of a seven-year old harbor porpoise after exposure to a 6.5 kHz continuous signal for 60 minutes at received SPLs ranging from 118 to 154 dB re: 1 µPa. The authors determined that the hearing frequency at which the maximum TTS occurred for the harbor porpoise was dependent on the noise level (SPL); the higher the SPL, the higher the TTS induced at frequencies higher than the exposure frequency (below 148 dB re: 1 µPa, the maximum TTS was at 6.5 kHz, whereas above 148 dB re: 1 µPa, the maximum TTS was at 9.2 kHz) (Kastelein et al. 2014b). Last Kastelein et al. (2014b) noted that recovery from TTS in the harbor porpoise, after small reductions in hearing sensitivity (threshold shifts less than 15 dB), is relatively quick (within 60 minutes) and that such a short-term reduction in hearing likely has little impact, but repeated hearing reductions over hours or days may become ecologically significant for the harbor porpoise.

Hearing loss resulting from auditory fatigue could effectively reduce the distance over which animals can communicate, detect biologically relevant sounds such as predators, and echolocate (for odontocetes). The costs to marine mammals with TTS, or even some degree of PTS have not been studied; however, hearing loss could have consequences to biologically important activities (e.g., intraspecific communication, foraging, and predator detection) that affect survivability and reproduction. If impaired, marine mammals would typically be aware of their impairment and would likely be able to implement behaviors to compensate. The brief amount of time marine mammals are expected to experience TTS is unlikely to significantly impair their ability to communicate, forage, or breed and will not have fitness level consequences at the individual or population level. Although PTS is a permanent shift in hearing, it is not the same as deafness and to our knowledge there are no published studies on the long-term effects of PTS on marine mammal fitness. Conceivably, PTS could result in changes to individual’s ability to communicate, breed, and forage but it is unclear if these impacts would significantly impact their fitness. For example, results from 2 years (2009 and 2010) of intensive monitoring by independent scientists and Navy observers in the Southern California and Hawaii Range Complexes have recorded an estimated 161,894 marine mammals with no evidence of distress or unusual behavior observed during Navy activities.

7.3.3 Behavioral Responses

One potential deleterious effect from SURTASS LFA sonar is change in a biologically significant behavior. The National Research Council (NRC 2005b) discussed biologically significant behaviors and possible effects and states that an action or activity becomes biologically significant to an individual animal when it affects the ability of the animal to grow, survive, and reproduce. These are the effects on individuals that can have population-level consequences and affect the viability of the species (NRC 2005b).

The behavioral response of a marine mammal to an anthropogenic sound will depend on the frequency, duration, temporal pattern and amplitude of the sound as well as the animal’s prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure, the distance from the sound source, and whether it is perceived as approaching or moving away) (Wartzok et al. 2003). For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson and others (Richardson et al. 1995e). Other reviews (Ellison et al. 2012b; Nowacek et al. 2007; Southall et al. 2009; Southall et al. 2007) address studies conducted since 1995 and focus on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated. Most recently, Southall et al. (2016) reviewed field experiments studying cetacean responses to simulated or actual military sonars in the 1 to 8 kHz band (higher frequencies than the LFA sonar considered in this opinion).

Except for some vocalization changes that may be compensating for concurrent auditory masking, all behavioral reactions are assumed to occur due to a preceding stress or cueing response, however stress responses cannot be predicted directly due to a lack of scientific data. Responses can also overlap. For example, an increased respiration rate is likely to be coupled with a flight response. Differential responses are expected among and within species since hearing ranges vary across species, the behavioral ecology of individual species is unlikely to completely overlap, and individuals of the same species may react differently to the same or similar, stressor.

Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions to specific sound level exposures. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal’s experience, motivation, and conditioning were also critical factors influencing the response (Southall et al. 2007). After examining all of the available data, the authors felt that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response. Nonetheless, in some conditions consistent avoidance reactions were noted at higher sound levels dependent on the marine mammal species or group allowing conclusions to be drawn.

Additional discussion on potential behavioral reactions of ESA-listed marine species to Navy mid-frequency active sonar is available in the most recent NMFS opinions for Navy training and testing in the Gulf of Alaska Training and Testing, Hawaii-Southern California Training and Testing, and the Mariana Islands Training and Testing study areas (NMFS 2015c; NMFS 2015f; NMFS 2017a). However, due to difference between mid- and low-frequency active sonar, we primarily rely on the literature described below. This literature primarily addresses potential behavioral responses of marine mammals to low-frequency active sonar.

7.3.3.1 *Low Frequency Sound Scientific Research Program*

As discussed previously in section 3.1.1.1, the Low Frequency Sound Scientific Research Program (LFS SRP) in 1997 through 1998 provided important results on, and insights into, the types of responses of baleen whales to LFA sonar signals and how those responses scaled relative to received level and context. The results of the LFS SRP confirmed that some portion of the total number of whales exposed to LFA sonar responded behaviorally by changing their vocal activity, moving away from the source vessel, or both, but the responses were short-lived (Clark and Fristrup 2001b).

In the LFS SRP LFA sonar playback experiment (Phase II), migrating gray whales avoided exposure to LFA sonar signals (source levels of 170 and 178 dB re: 1 µPa [rms] sound pressure level) when the source was placed in the center of their migration corridor. Responses were similar for the 170 dB source level LFA sonar stimuli and for the 170 dB source level 1/3rd-octave, band-limited noise with timing and frequency band similar to the LFA sonar stimulus. However, during the LFA sonar playback experiments, in all cases, whales resumed their normal activities within tens of minutes after the initial exposure to the LFA sonar signal (Clark and Fristrup 2001b). Essentially, the whales made minor course changes to go around the source. When the source was relocated within the outer portion of the migration corridor (twice the distance offshore), and the source level was increased to reproduce the same sound field for the central corridor playback condition, the gray whales showed little to no response to the LFA sonar source. This result stresses the importance of context in interpreting the animals' behavioral responses to underwater sounds and demonstrates that received level is not necessarily a good predictor of behavioral impact.

The Phase II research also demonstrated that it may not be valid to generalize results from inshore studies (2 km [1.1 nmi] from shore when 50 percent of the whales avoided SURTASS LFA sonar stimuli at received levels of 141+3 dB) to sources that are offshore (4 km [2.2 nmi] from shore) of migrating whales (whales did not avoid offshore sources at received levels of 140 dB). This implies that the inshore avoidance model, in which 50 percent of the whales avoid exposure to levels of 141+3 dB, may not be valid for whales in proximity to an offshore source (Buck and Tyack 2000).

The LFS SRP also conducted field tests to examine the effects of LFA sonar transmissions on foraging fin and blue whales off San Nicolas Island, California (Phase I). Overall, whale encounter rates and dive behavior appeared to be more strongly linked to changes in prey abundance associated with oceanographic parameters rather than LFA sonar sound transmissions (Croll et al. 2001). However, in a separate study on the Atlantic coast, five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives, although the alarm signal was long in duration, lasting several minutes, and purposely designed to elicit a reaction from the animals as a prospective means to protect them from ship strikes (Nowacek et al. 2004b). Although the animal's received sound pressure level was similar in the latter two studies (133 to 150 dB re: 1 µPa), the frequency, duration, and temporal pattern of signal presentation were different. Additionally, the North Atlantic right whales did not respond to playbacks of either North Atlantic right whale social sounds or vessel noise, highlighting the importance of the sound characteristics, species differences, and individual sensitivity in producing a behavioral reaction.

In the final phase of the LFS SRP (Phase III), the effect of LFA sonar on humpback whales during the winter mating season was investigated. Both Miller et al. (2000b) and Firstup et al. (2003) published results from tests conducted with male humpback singers off the Big Island, Hawaii during which they evaluated variation in song length as a function of exposure to LFA sonar sounds. Fristup et al. (2003) used a larger data set to describe song length variability and to explain song length variation in relation to LFA sonar broadcasts. In spite of methodological and sample size differences, the results of the two analyses were generally in agreement, and both studies indicated that humpback whales might lengthen their songs in response to low frequency broadcasts. The Fristup et al. (2003) results also provided a detailed picture of short-term response as compared to behavioral variation observed in the absence of the stimuli. These responses were relatively brief in duration, with all observed effects occurring within two hours of the last LFA sonar source transmission. It should be noted that these effects were not obvious to the acoustic observers on the scene, but were revealed by careful, complex post-test statistical analyses (Fristup et al. 2003). Aside from the delayed responses, other measures failed to indicate cumulative effects from LFA sonar broadcasts, with song-length response being dependent solely on the most recent LFA sonar transmission, and not the immediate transmission history. The modeled seasonal factors (changes in density of whales sighted near shore) and diurnal factors (changes in surface social activities) did not show trends that could be plausibly explained by cumulative exposure. Increases in song length from early morning to afternoon were the same on days with and without LFA sonar transmissions, and the fraction of variation in song length that could be attributed to LFA sonar broadcast was small (less than ten percent). Fristup et al. (2003) found high levels of natural variability in humpback song length and interpreted the whales’ responses to LFA sonar broadcasts to indicate that exposure to LFA sonar would not impose a risk of dramatic changes in humpback whale singing behavior that would have demographic consequences.

Taken together, the data generated during the three phases of the LFS SRP did not support the initial hypothesis that most baleen whales exposed to received levels near 140 dB would exhibit behavioral changes and avoid the area. These experiments, which exposed baleen whales to received level ranging from 120 to about 155 dB, detected only minor, short-term behavioral responses. As documented below, the conclusions from the LFS SRP are supported by other studies of whale responses to low frequency, anthropogenic sounds.

7.3.3.2 *Other Literature*

Richardson et al. (1995e) noted that avoidance reactions are the most obvious manifestations of disturbance in marine mammals. Richardson et al. (1985b) and Richardson (1997) used controlled playback experiments to study the response of bowhead whales in Alaska. In their studies, bowhead whales tended to avoid drill ship noise at estimated received levels of 110 to 115 dB and seismic sources at estimated received levels of 110 to 132 dB. Richardson et al. (1995e) concluded that some marine mammals would tolerate continuous sound at received levels above 120 dB re: 1 μPa for a few hours. These authors concluded that most marine mammals would avoid exposures to received levels of continuous underwater noise greater than 140 dB when source frequencies were in the animal’s most sensitive hearing range.

Several authors noted that migrating whales are likely to avoid stationary sound sources by deflecting their course slightly as they approached a source (LGL and Greenridge 1987 in Richardson et al. 1995e). A study examined responses of gray whales migrating along the California coast to various sound sources located in their migration corridor (Malme et al. 1983;

Malme et al. 1984). Gray whales showed statistically significant responses to four different underwater playbacks of continuous sounds at received levels of approximately 120 dB. The sources of the playbacks were typical of a drillship, semisubmersible, drilling platform, and production platform.

Bowhead and gray whales, showed clear patterns of short-term, behavioral disturbance in response to a variety of actual and simulated vessel activity and noise (Malme et al. 1983; Richardson et al. 1985a). Richardson et al. (1995c) noted that whales have been seen within a few kilometers of operating seismic vessels, although they added that any discomfort the seismic sound pulses may have caused remains unknown. Humpback whales showed similar patterns on their summering grounds (Bauer and Herman 1986) and on their wintering grounds (Bauer 1986) in response to vessel noise. Richardson et al. (1995c) argued that intermittent pulses with peak levels between 160 to 180 dB are less likely to cause discomfort than continuous sounds at the same sound pressure levels.

In the Caribbean Sea, sperm whales avoided exposure to mid-frequency submarine sonar pulses, in the range 1 to 10 kHz (IWC 2005). Blue and fin whales have occasionally been reported in areas ensonified by airgun pulses. Systematic data on their reactions to airguns are generally lacking. Sighting by observers on seismic vessels off the United Kingdom suggest that, at times of good sightability, the number of blue, fin, sei, and humpback whales seen when airguns are shooting are similar to the numbers seen when the airguns are not shooting (Stone 1997; Stone 1998; Stone 2000; Stone 2001). However, fin and sei whale sighting rates were higher when airguns were shooting, which may be due to a tendency to remain at or near the surface at times of airgun operation (Stone 2003). The analysis of the combined data from all years indicated that baleen whales stayed farther from airguns during periods of shooting (Stone 2003). Baleen whales also altered course more often during periods of shooting and more were headed away from the vessel at these times, indicating some level of localized avoidance of seismic activity (Stone 2003).

Sperm whales reacted to military sonar, apparently from a submarine, by dispersing from social aggregations, moving away from the sound source, remaining relatively silent, and becoming difficult to approach (Watkins et al. 1985c). Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to one second pulsed sounds at frequencies similar to those emitted by multi-beam sonar that is used by geophysical surveys (Ridgway et al. 1997; Schlundt et al. 2000b), and to shorter broadband pulsed signals (Finneran et al. 2000a; Finneran et al. 2002a).

Behavioral changes often appear to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al. 2000a; Schlundt et al. 2000b). Dolphins exposed to one-second intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re: 1 µPa (rms) and beluga whales did so at received levels of 180 to 196 dB and above. Received levels necessary to elicit such reactions to shorter pulses were higher (Finneran et al. 2000a; Finneran et al. 2002a). Test animals sometimes vocalized after exposure to pulsed, mid-frequency sound from a watergun (Finneran et al. 2002b). In some instances, animals exhibited aggressive behavior toward the test apparatus (Finneran et al. 2000a; Ridgway et al. 1997).

Nowacek et al. (2004a) conducted controlled exposure experiments on North Atlantic right whales using ship noise, social sounds of conspecifics, and an alerting stimulus (frequency modulated tonal signals between 500 Hz and 4.5 kHz). Animals were tagged with acoustic sensors (D-tags) that simultaneously measured movement in three dimensions. Whales reacted strongly to alert signals at received levels of 133 to 148 dB sound pressure level, mildly to conspecific signals, and not at all to ship sounds or actual vessels. The alert stimulus caused whales to immediately cease foraging behavior and swim rapidly to the surface.

There is evidence that wild animals respond to human disturbance in the same way that they respond to predators (Beale and Monaghan 2004; Frid 2003; Frid and Dill 2002; Gill and Sutherland 2001; Romero 2004). These responses manifest themselves as stress responses (in which an animal perceives human activity as a potential threat and undergoes physiological changes to prepare for a flight or fight response or more serious physiological changes with chronic exposure to stressors), interruptions of essential behavioral or physiological events, alteration of an animal’s time budget, or some combinations of these responses (Frid and Dill 2002; Romero 2004; Sapolsky et al. 2000; Walker et al. 2005). These responses have been associated with abandonment of sites (Sutherland and Crockford 1993), reduced reproductive success (Giese 1996; Müllner et al. 2004), and the death of individual animals (Daan et al. 1996).

Brownell (2004) reported observations of the effects of behavioral disturbance on the endangered Western North Pacific population of gray whales off the northeast coast of Sakhalin Island associated with seismic activities in that region. In 1997, various behavioral disturbances concomitant with seismic activities were observed including changes in swimming speed and orientation, respiration rates, and distribution offshore. Cumulative impacts of these short-term disturbances are not known. In 2001, seismic activities were conducted in the known feeding area of these whales. It was observed that whales left the feeding ground during these activities and moved to areas farther south. They only returned to the feeding ground after the seismic activities ceased days later. The potential impacts on these whales, especially mother-calf pairs and “skinny whales,” of being displaced to the south outside the normal feeding area are not known but are cause for concern.

One study of blue whales reported that when pulses from airguns were produced off Oregon, blue whales continued vocalizing at the same rate as before the pulses, suggesting that at least their vocalization behavior was undisturbed by the sound (McDonald et al. 1993).

Watkins (1986) reviewed data on the reactions of fin, humpback, North Atlantic right, and minke whales that were exposed to continuous, broadband low-frequency shipping and industrial noise in Cape Cod Bay. Watkins (1986) concluded that underwater sound was the primary cause of a reaction in these species of whales and that whales responded to acoustic stimuli in their range of hearing. Watkins also noted that whales showed the strongest reactions to sounds in the 15 Hz to

28 kHz range, although negative reactions (avoidance, interruptions in vocalizations, etc.) were generally associated with sounds that were either unexpected, too loud, suddenly louder or different, or perceived as being associated with a potential threat (such as an approaching ship on a collision course). In particular, whales seemed to react negatively when they were within 100 m (328 ft) of the source or when received levels increased suddenly in excess of 12 dB relative to ambient sounds. At other times, the whales ignored the source of the signal and all four species habituated to these sounds. Nevertheless, Watkins concluded that whales ignored most sounds in the background of ambient noise, including the sounds from distant human activities even though these sounds may have had considerable energies at frequencies well within the whale’s range of hearing. Further, Watkins (1986) noted that fin whales were initially the most sensitive of the four species of whales, followed by humpback whales; North Atlantic right whales were the least likely to be disturbed and generally did not react to low-amplitude engine noise. By the end of this period of study, Watkins (1986) concluded that fin and humpback whales have generally habituated to the continuous, broad-band, noise of Cape Cod Bay while North Atlantic right whales did not appear to change their response. This study covered a long enough period (the data covered 25 years of time) to provide some insight into possible long-term effects of low-frequency noise on whales, particularly since the four whale species would be exposed to continuous, low-frequency noise from shipping and other industrial sources. Given that whales in Cape Cod Bay reacted negatively to these continuous sources of anthropogenic sounds only under specific circumstances and, over time, habituated to these sounds (rather than abandoned the area), it seems unlikely that an additional, intermittent signal lasting from six to 100 seconds that is designed to mimic background, low frequency sound would have a greater negative effect on at least these species of whales (fin, humpback, North Atlantic right, and minke whales). The studies associated with the LFS SRP suggest the same conclusions may also apply to blue, gray, and fin whales.

A study of an LFA sonar system that was being developed for use by the British Navy monitored the behavioral responses of marine mammals to the LFA sonar (Aicken et al. 2005). During these trials, fin whales, sperm whales, Sowerby’s beaked whales (*Mesoplodon bidens*), long-finned pilot whales (*Globicephala melas*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), and common bottlenose dolphins were observed and recorded vocalizing. These studies found no evidence of behavioral responses that could be attributed to the LFA sonar during these trials (some of the responses that were observed may have been to the vessels used for the monitoring).

Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were not found to affect dive times of humpback whales in Hawaiian waters (Frankel and Clark 2000) or to overtly affect Northern elephant seal dives off California (Costa et al. 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, again illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Work by Risch et al. (2012) found that humpback whale vocalizations were reduced concurrently with pulses from the low frequency Ocean Acoustic Waveguide Remote Sensing (OAWRS) source located approximately 200 km (108 nmi) away. The OAWRS source appears to have affected more whales, by producing a greater response with a lower sound source level, than reported from the Phase III of the LFS SRP, even though OAWRS had a lower received level (88 to 110 dB re: 1 μPa) than the LFA signal. This strongly suggests that other acoustic characteristics may be responsible for the difference in observed behavioral responses. Risch et al. (2012) stated that due to differences in behavioral context, location, and proximity to the source, it is difficult to compare their findings directly to Phase III of the LFS SRP. These observations are consistent with the importance of considering context in predicting and observing the level and type of behavioral response to anthropogenic signals (Ellison et al. 2012b). Gong et al. (2014) reported on their reassessment of the effects from exposure to the OAWRS source on humpback whales and determined that the constant occurrence rate of humpback whale songs indicated that they low frequency OAWRS source transmissions had no effect on humpback whale song, contrary to what Risch et al. (2012) reported. Gong et al. (2014) attributed the variation in song occurrence Risch et al. (2012) described as due to natural causes other than sonar since the change in song occurrence began before the OAWRS began transmitting. Risch et al. (2014) responded to the Gong et al. (2014) assessment by stating that both their original and the Gong et al. (2014) findings may be correct, highlighting the multifactorial and context-dependent nature of behavioral responses. Risch et al. (2014) pointed out that the principal point of their original paper had been the importance of behavioral context, ambient noise, and the novelty received sounds when assessing anthropogenic impacts on marine mammals.

Antunes et al. (2014) conducted experiments using simulated European low frequency (one to two kHz) and mid-frequency (six to seven kHz) naval sonar to determine if transmission frequency had an effect on the behavioral response threshold for long-finned pilot whales. The experiment used a new method to quantify the dose threshold at which free-ranging long-finned pilot whales began to avoid an approaching vessel transmitting sonar, consisting of a statistical analysis of the movements of the whales to indicate changes in behavior and a Bayesian dose-response model using the observed response thresholds (Antunes et al. 2014). Long-finned pilot whale movements during the duration of sonar transmissions changed to indicate an avoidance response, with a shorter response duration than reported for other marine mammal species, including Cuvier’s (*Ziphius cavirostris*) and Blainville’s beaked whales (*Mesoplodon densirostris*) and killer whales. The observed response thresholds occurred at 50 percent higher levels (approximately 170 dB re: 1 μPa or 173 dB $\mathrm{SEL_{cum}}$) than described for other cetacean species (Antunes et al. 2014).

Miller et al. (2014) conducted eight controlled exposure experiments on killer whale groups using the same simulated European low frequency (one to two kHz) and mid-frequency (six to seven kHz) naval sonar used in the Antunes et al. (2014) experiments. The source level and distance to the source were increased during each exposure to reveal response thresholds.

Changes in movements (swim speed and direction) during exposure to the transmitted sonar signals were evaluated as avoidance responses and animals began to avoid the sonar at received levels sound pressure levels of 142±15 dB re: 1 µPa (Miller et al. 2014), which is below the threshold assumed by the Navy (Finneran and Jenkins 2012). High levels of between and within individual variability were identified, and the context of exposure was recognized as an important factor, particularly since the sound source changed course to continue moving towards the animals, even after they exhibited avoidance responses.

Southall et al. (2007) reviewed the relatively extensive behavioral observations of low frequency cetaceans exposed to non-pulse sources. While there are clearly major areas of uncertainty, Southall et al. (2007) concluded that the literature indicated that there were no (or very limited) responses to received levels of 90 dB to 120 dB sound pressure level with an increasing probability of avoidance and other behavioral effects in the 120 to 160 dB sound pressure level (received level) range. See Southall et al. (2016) for an even more recent review on various controlled exposure experiments to measure behavioral response (or lack thereof) of marine mammals to sonar signals.

While not specific to the low-frequency sonar of the proposed action, both Goldbogen et al. (2013) and Melcon et al. (2012) indicated that behavioral responses to simulated or operational MFA sonar were temporary, with whales resuming normal behavior quickly after the cessation of sound exposure. Further, responses were discernible for whales in certain behavioral states (i.e., deep feeding), but not in others (i.e., surface feeding). As stated in Goldbogen et al. (2013) when summarizing the responses of blue whales to simulated MFA sonar, “we emphasize that elicitation of the response is complex, dependent on a suite of contextual (e.g., behavioral state) and sound exposure factors (e.g., maximum received level), and typically involves temporary avoidance responses that appear to abate quickly after sound exposure.” Melcon et al. (2012) reported that blue whales exposed to mid-frequency sonar in the Southern California Bight were less likely to produce low frequency calls (D calls) usually associated with feeding behavior. However, they were unable to determine if suppression of D calls reflected a change in their feeding performance or abandonment of foraging behavior that could potentially have impacts on individual fitness and eventually, population health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since unconsumed prey would likely still be available in the environment following the cessation of acoustic exposure. Preliminary results from the 2010 to 2011 field season of an ongoing behavioral response study in Southern California waters indicated that in some cases and at low received levels, tagged blue whales responded to mid-frequency sonar but that those responses were mild and there was a quick return to their baseline activity (Southall et al. 2011a). Blue whales responded to a mid-frequency sound source, with a source level between 160 and 210 dB re: 1 µPa at 1 m and a received sound level up to 160 dB re: 1 µPa, by exhibiting generalized avoidance responses and changes to dive behavior during controlled exposure experiments

(Goldbogen et al. 2013). However, reactions were not consistent across individuals based on received sound levels alone, and likely were the result of a complex interaction between sound exposure factors such as proximity to sound source and sound type (mid-frequency sonar simulation vs. pseudo-random noise), environmental conditions, and behavioral state. Surface feeding whales did not show a change in behavior during controlled exposure experiments, but deep feeding and non-feeding whales showed temporary reactions that quickly abated after sound exposure. Whales were sometimes less than a mile from the sound source during controlled exposure experiments. We would expect similar context dependent, temporary responses from any cetaceans exposed to LFA sonar.

7.3.4 Physiological Stress

Classic stress responses begin when an animal’s central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg 2000; Sapolsky 2006; Seyle 1950). Once an animal’s central nervous system perceives a threat, it mounts a biological response or defense that may consist of a combination of several biological defense responses including, but not limited to, behavioral responses, autonomic nervous system responses, or neuroendocrine responses.

In the case of many stressors, the first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal’s second line of defense to stressors involves the autonomic nervous system and the classical “fight or flight” response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with stress. These responses have a relatively short duration and may or may not have significant long-term effects on an animal’s welfare.

An animal’s third line of defense to a stressor involves its neuroendocrine systems, usually hormones associated with the hypothalamus-pituitary-adrenal system (most commonly known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuroendocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987; Rivier 1985) and altered metabolism (Elsasser et al. 2000), immune competence (Blecha 2000) and behavior. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals) are equated with stress.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During stress, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response does not pose a risk of the animal’s welfare.

However, when an animal has insufficient biotic reserves to satisfy the biotic cost of a stress response, then resources must be shifted away from other biotic functions. When sufficient reserves are diverted from these functions, the functions are impaired. For example, when stress shifts metabolism away from growth, depending on severity of the shift, young animals may no longer thrive and growth may be stunted. When energy is shifted from supporting reproduction, reproductive success may be diminished.

In these cases, animals have entered a pre-pathological state and are experiencing “distress” (sensu Seyle 1950) or “allostatic loading” (sensu McEwen and Wingfield 2003). This period of distress will last until the animal replenishes its biotic reserves sufficient to restore normal function.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (Holberton et al. 1996; Hood et al. 1998; Jessop et al. 2003; Lankford et al. 2005).

No information has been collected on the physiological responses of marine mammals upon exposure to anthropogenic sounds. Studies of other marine animals and terrestrial animals would lead us to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as “distress” upon exposure to mid-frequency and low-frequency sounds. For example, when bowhead and gray whales were exposed to various types of man-made noise, their surfacings become unusually brief with fewer blows per surfacing (Malme et al. 1989; Richardson et al. 1985c; Richardson et al. 1990; Richardson et al. 1986). These authors concluded that changes in surfacing, respiration, and diving behavior may be indicators of stress, although their consequences on the population ecology of the animals that are affected remain unknown.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, and interactions with predators all contribute to the stress a marine mammal experiences. In some cases, naturally occurring stressors can have profound impacts on marine mammals. For example, chronic stress, as observed in stranded animals with long-term debilitating conditions (e.g., disease), has been demonstrated to result in an increased size of the adrenal glands and an increase in the number of epinephrine-producing cells (Clark et al. 2006).

Anthropogenic activities have the potential to provide additional stressors above and beyond those that occur naturally. Stress responses to sound exposures have been studied in other animal species, including humans. Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (for example, elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998)

reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman et al. (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn (*Antilocapra americana sonoriensis*) to military overflights. Smith et al. (2004a; 2004b) identified noise-induced physiological stress responses in hearing-specialist fish that accompanied hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Various efforts have investigated the impact of vessels on marine mammals (both whale-watching and general vessel traffic noise) and demonstrated that impacts do occur (Bain 2002; Erbe 2002b; Noren et al. 2009; Pirotta et al. 2015; Williams and Ashe 2006; Williams and Noren 2009). In analysis of energy costs to killer whales, Williams et al. (2009) suggested that whale-watching in the Johnstone Strait resulted in lost feeding opportunities due to vessel disturbance. Ayres et al. (2012) measured fecal hormones of Southern Resident DPS of killer whales in the Salish Sea to assess the lack of prey (salmon) and vessel traffic on species recovery. Ayres et al. (2012) suggested that the lack of prey overshadowed any population-level physiological impacts on Southern Resident DPS of killer whales from vessel traffic.

Marine mammals may exhibit a behavioral response or combinations of behavioral responses upon exposure to anthropogenic sounds. If a sound is detected by a marine mammal, a stress response (e.g., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Although preliminary because of the small numbers of samples collected, different types of sounds have been shown to produce variable stress responses in marine mammals. Belugas demonstrated no catecholamine (hormones released in situations of stress) response to the playback of oil drilling sounds (Thomas et al. 1990a), but the species has shown an increase in catecholamines following exposure to impulsive sounds produced from a seismic watergun (Romano et al. 2004). A bottlenose dolphin exposed to the same seismic watergun signals did not demonstrate a catecholamine response, but did demonstrate an elevation in aldosterone, a hormone that may be a significant indicator of stress in odontocetes (St. Aubin et al. 2001; St. Aubin and Geraci 1989). Increases in heart rate were observed in bottlenose dolphins to which conspecific calls were played, although no increase in heart rate was observed when take noise was played back (Miksis et al. 2001). Collectively, these results suggest a variable response that depends on the characteristics of the received signal and prior experience with the received signal.

Hearing is one of the primary senses cetaceans use to gather information about their environment and to communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on cetaceans remains limited, it is reasonable to assume that reducing an animal’s ability to gather information about its environment and to communicate with other members of its species would be stressful for animals that use hearing as their primary sensory mechanism. Therfore, we assume that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses because terrestrial animals exhibit those responses under similar conditions (NRC

2003a). Marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS (e.g., if exposure caused a significant behavioral response). Based on empirical studies of the time required to recover from stress responses (Moberg 2000), we also assume that stress responses may persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

Other types of stressors include the presence of vessels, fishery interactions, acts of pursuit and capture, the act of stranding, and pollution. In contrast to the limited amount of work performed on stress responses resulting from sound exposure, a considerable larger body of work exists on stress responses associated with pursuit, capture, handling and stranding. A study compared pathological changes in organs/tissues of odontocetes stranded on beaches or captured in nets over a 40-year period (Cowan and Curry 2008). The type of changes observed indicate multi-systematic harm caused in part by an overload of catecholamines into the system, as well as a restriction in blood supply capable of causing tissue damage or tissue death. This response to a stressor or stressors is thought to be mediated by the over-activation of the animal's normal physiological adaptations to diving or escape. Pursuit, capture and short-term holding of belugas have been observed to result in decreased thyroid hormones (St. Aubin and Geraci 1988) and increases in epinephrine (St. Aubin and Dierauf 2001). In dolphins, the trend is more complicated with the duration of the handling time potentially contributing to the magnitude of the stress response (Ortiz and Worthy 2000; St. Aubin 2002; St. Aubin et al. 1996). Male grey seals subjected to capture and short-term restraint showed an increase in cortisol levels accompanied by an increase in testosterone (Lidgard et al. 2008). This result may be indicative of a compensatory response that enable the seal to maintain reproduction capability in spite of stress. Elephant seals demonstrate an acute cortisol response to handling, but do not demonstrate a chronic response; on the contrary, adult females demonstrate a reduction in the adrenocortical response following repetitive chemical immobilization (Engelhard et al. 2002). Similarly, no correlation between cortisol levels and heart/respiration rate changes were seen in harbor porpoises during handling for satellite tagging (Eskesen et al. 2009). Taken together, these studies illustrate the wide variations in the level of response that can occur when faced with these stressors.

In summary, factors to consider when trying to predict a stress or cueing response include the mammal's life history stage and whether they are experienced with the stressor. Prior experience with a stressor may be of particular importance as repeated experience with a stressor may dull the stress response via acclimation (St. Aubin and Dierauf 2001). The sound characteristics that correlate with specific stress responses in marine mammals are poorly understood. Therefore, in practice and for the purposes of this opinion, a stress response is assumed if a physical injury such as hearing loss or trauma is predicted; or if a significant behavioral response is predicted.

7.3.5 Masking

Auditory masking occurs when a sound, or noise in general, limits the perception of another sound. As with hearing loss, auditory masking can effectively limit the distance over which a marine mammals can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Unlike auditory fatigue, which always results in a localized stress response, behavioral changes resulting from auditory masking may not be coupled with a stress response. Another important distinction between masking and hearing loss is that masking only occurs in the presence of the sound stimulus, whereas hearing loss can persist after the stimulus is gone. As a general statement, the more similar the characteristics (i.e., frequency band, duration) of a masking sound are to the sound of interest, the greater its potential for masking.

Acoustic masking from low frequency ocean noise is increasingly being considered as a threat, especially to low-frequency hearing specialists such as baleen whales (Clark et al. 2009). Most underwater low-frequency anthropogenic noise is generated by commercial shipping, which has contributed to the increase in oceanic background noise over the past 150 years (Parks et al. 2007a). Shipping noise is primarily in the 20 to 200 Hz frequency band and is increasing yearly (Ross 2005). Andrew et al. (2002) demonstrated an increase in oceanic ambient noise of ten dB sound pressure level since 1963 in the 20 to 80 Hz frequency band as sampled on the continental slope off Point Sur, California, and they ascribed this increase to increased commercial shipping. McDonald et al. (2006a) compared data sets from 1964 to 1966 and 2003 to 2004 for continuous measurements west of San Nicolas Island, California, and found an increase in ambient noise levels of ten to 12 dB sound pressure level in the 30 to 50 Hz band. This increase in low frequency background noise could be having a widespread impact on marine mammal low-frequency hearing specialists by reducing their access to acoustic information essential for con-specific communication and other biologically important activities, such as navigation and prey/predator detection. Clark et al. (2009) considered this long-term, large-scale increase in low frequency background noise a chronic impact that results in a reduction in communication space, and the loss of acoustic habitat.

Clark et al. (2009) developed a methodology for estimating masking effects on communication signals for low frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates that in Stellwagen Bank National Marine Sanctuary, when two commercial vessels pass through a North Atlantic right whale’s (a baleen whale like blue, Bryde’s, fin, gray, and humpback whales) optical communication space (estimated as a sphere of water with a diameter of 20 km [11 nmi]), that space is decreased by 84 percent. This methodology relies on empirical data on source levels of calls (which is unknown for many species), and requires many assumptions about ancient ambient noise conditions and simplifications of animal behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication. Subsequent research for the same species and location estimated that an average of 63 to 67 percent of North Atlantic right whale’s communication space has been reduced by an increase in ambient noise levels, and that noise associated with transiting vessels is a major contributor to the increase in ambient noise (Hatch et al. 2012).

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Changes to vocal behavior and call structure may result from a need to compensate for an increase in background noise. In cetaceans, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Dahlheim et al. (1984) concluded that gray whales in the San Ignacio Lagoon, Baja, California shifted the frequencies of their vocalizations away from the predominant ambient noise producers in the lagoon to overcome masking effects. Biassoni et al. (2001) concluded that the intermittent sounds produced by LFA sonar were unlikely to mask humpback whale songs, but the similarities of its sounds to those produced by the whales could cause some humpback whales to perceive LFA sonar as a competing male. Based on their studies, they concluded that humpback whales could adapt to the presence of LFA sonar and concluded that singing whales could compensate for interference from sound sources like LFA sonar.

Parks et al. (2007a) provided evidence of behavioral changes in the acoustic behaviors of the endangered North Atlantic right whale, and the Southern right whale, and suggested that these were correlated to increased underwater noise levels. The study indicated that right whales might shift the frequency band of their calls to compensate for increased background noise. The significance of their result is the indication of potential species-wide behavioral change in response to gradual, chronic increases in underwater ambient noise. DiLorio and Clark (2010) showed that blue whale calling rates vary in association with seismic sparker survey activity, with whales calling more on days with surveys than on days without surveys. They suggested that the whales called more during seismic survey periods as a way to compensate for the elevated noise conditions.

In the presence of LFA sonar, humpback whales have been observed to increase the length of their ‘songs’ (Fristrup et al. 2003; Miller et al. 2000a), possibly due to the overlap in frequencies between the whale song and the LFA sonar. North Atlantic right whales have been observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al. 2007a) as well as increasing the amplitude (intensity) of their calls (Parks 2009a). In contrast, both sperm whales and long-finned pilot whales potentially ceased sound production during the Heard Island feasibility test (Bowles et al. 1994), although it cannot be absolutely determined whether the inability to acoustically detect the animals was due to the cessation of sound production or the displacement of animals from the area.

Holt et al. (2009) measured killer whale call source levels and background noise levels in the one to 40 kHz band. The whales increased their call source levels by one dB for every one dB increase in background noise level. A similar rate of increase in vocalization activity was reported for St. Lawrence River beluga whales in response to passing vessels (Scheifele et al. 2005).

Differential vocal responding in marine mammals has been documented in the presence of seismic survey noise. An overall decrease in vocalization during active surveying has been noted in large marine mammals groups (Potter et al. 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Lorio and Clark 2010), indicative of a potentially compensatory response to the increased noise level. Melcon et al. (2012) recently documented that blue whales decreased the proportion of time spent producing certain types of calls when simulated mid-frequency sonar was present. Castellote et al. (2012) found that vocalizing fin whales in the Mediterranean Sea left the area where a seismic survey was being conducted and that their displacement persisted beyond the completion of the survey. At present, it is not known if these changes in vocal behavior corresponded to changes in foraging or any other behaviors. Controlled exposure experiments in 2007 and 2008 in the Bahamas recorded responses of false killer whales, short-finned pilot whales, and melon-headed whales (*Peponocephala electra*) to simulated MFA sonar (Deruiter et al. 2013). The responses of exposures between species were variable. After hearing each MFA signal, false killer whales were found to “increase their whistle production rate and made more-MFA-like whistles” (Deruiter et al. 2013). In contrast, melon-headed whales had “minor transient silencing” after each MFA signal, while pilot whales had no apparent response. Consistent with the findings of other previous research (see, for example, (Southall et al. 2007)), Deruiter et al. (2013) found the responses were variable by species and with the context of the sound exposure.

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales, but not others. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al. 2002), a capability that should increase survivorship while reducing the energy required for attending to and responding to all killer whale calls. The occurrence of masking or hearing impairment provides a means by which marine mammals may be prevented from responding to the acoustic cues produced by their predators. Whether or not this is a possibility depends on the duration of the masking/hearing impairment and the likelihood of encountering a predator during the time that predator cues are impeded.

Like Richardson et al. (1995e), we assume that baleen whales are very sensitive to low-frequency sounds. As a result, masking effects could occur for many of these whales because they vocalize at low frequencies and are thought to have hearing that is sensitive at the SURTASS LFA sonar frequencies. However, masking effects from SURTASS LFA sonar signals will be limited for a number of reasons. First, the bandwidth of any LFA sonar transmitted signal is limited (30 Hz), and the instantaneous bandwidth at any given time of the signal is small, on the order of approximately ten Hz. Therefore, within the frequency range in which masking is possible, the effect will be limited because animals that use this frequency range typically use signals with greater bandwidths. Thus, only a portion of frequency band for the animal's signal is likely to be masked by the LFA sonar transmissions. Furthermore, when LFA sonar is in operation, the LFA sonar source is active only 7.5 to ten percent of the time (based on historical LFA sonar operational parameters), which means that for approximately 92.5 percent of the time, there is no risk that an animal's signal will be masked by LFA sonar. Therefore, within the area in which masking is possible, any effect of LFA sonar transmission will be minimal because of the limited bandwidth and intermittent nature of the signal, and the fact that animals that use this frequency region typically produce signals with greater bandwidth that are repeated for many hours.

The echolocation calls of toothed whales are subject to masking by high frequency sound. However, since echolocation calls occur at much higher frequencies than SURTASS LFA sonar, the extent of upward masking (i.e., low frequencies masking high frequencies) would be limited. Additionally, studies on captive odontocetes by Au et al. (1993; 1985; 1974) indicated that some species may use various processes to reduce masking effects (e.g., adjustments in echolocation call intensity or frequency as a function of background noise conditions). There is also evidence that the directional hearing abilities of odontocetes are useful in reducing masking at the high frequencies used for echolocation, but not at the low-moderate frequencies used for communication (Zaitseva et al. 1980).

Although low frequency hearing has not been studied in many odontocete species, those species that have been tested (beluga whale, killer whale, falser killer whale, Risso's dolphin [*Grampus griseus*], and bottlenose dolphin) exhibit poor audiometric and behavioral sensitivity to low frequency sound. For sounds dominated by low frequency components, the maximum radius of audibility for most odontocete species may often be noise-limited when sensitivity is good, and sensitivity-limited when sensitivity is poor.

Hildebrand (2005) provided a comparison of anthropogenic underwater sound sources by their annual energy output. On an annual basis, four LFA sonar systems were estimated to have a total energy output of 6.8×10^{11} Joules per year. Seismic airgun arrays and mid-frequency military sonars were two orders of magnitude greater, with an estimated annual output of 3.9 and 2.6×10^{13} Joules per year, respectively. Super tankers were estimated at 3.7×10^{12} Joules per year. Hildebrand (2005) concluded that anthropogenic sources most likely to contribute to increased underwater noise in order of importance are: commercial shipping, offshore oil and gas exploration and drilling, and naval and other uses of sonar. The percentage of the total anthropogenic acoustic energy budget added by each LFA sonar source is estimated to be 0.21 percent per system (or less), when the other man-made sources are considered (Hildebrand 2005). When combined with the naturally occurring and other man-made sources of noise in the oceans, the intermittent LFA sonar signals barely contribute a measurable portion of the total acoustic energy.

The research reviewed above indicates that masking in marine mammals due to narrowband, intermittent (low duty cycle) LFA sonar signal transmission is expected to be minimal. The operation of SURTASS LFA sonar is not expected to result in extended period of time where masking could occur. At a maximum 20 percent duty cycle for SURTASS LFA sonar (but an average of 7.5 percent), it is anticipated that any masking would be temporary (i.e., at least 80 percent of the time an animal would be able to perceive incoming signals through low frequency sounds). The possibility of effective masking would only occur for environmental sounds that happen during the ping transmission (maximum 100 seconds) and are at, or at least close to, the frequencies in the 30 Hz wide bandwidth signal, during the ten seconds the SURTASS LFA sonar was transmitting in that bandwidth. This indicates biological relevant sounds for individuals in close proximity would only be masked for this short, intermittent, period of time. Furthermore, SURTASS LFA sonar missions are geographically and temporally dispersed. These factors reduce the likelihood of sources causing significant auditory masking in marine mammals. As a result, the available evidence does not lead us to expect masking to reduce the reproduction, numbers, or distribution of threatened or endangered marine mammals.

7.3.6 Stranding

Stranding is a potential risk for cetaceans. Stranding occurs when marine mammals passively (unintentionally) or purposefully come ashore either alive, but debilitated or disoriented, or dead. Although some species of marine mammals, such as pinnipeds, routinely come ashore during all or part of their life history, stranded marine mammals are differentiated by their helplessness ashore and inability to cope with or survive their stranded situation (i.e., they are outside their natural habitat (Geraci and Lounsbury 2005).

Strandings of multiple marine mammals, or mass strandings, occur only rarely. A mass stranding of marine mammals is the stranding of two or more unrelated cetaceans (i.e., not a mother-calf pair) of the same species coming ashore at the same time and place (Geraci and Lounsbury 2005). Mass strandings typically involve pelagic odontocete marine mammal species that occur infrequently in coastal waters and are usually typified by highly developed social bonds. Marine mammal strandings and mortality events are natural events, and such events continue to occur throughout the world’s oceans.

Over the last four decades, marine mammal stranding networks have become established, and the reporting of marine mammal stranding and mortality events has become better documented and publicized. This has led to increased public awareness and concern, especially regarding the potential for anthropogenic causes of stranding and mortality events. Underwater noise, particularly sounds generated by military sonar or geophysical and geologic seismic exploration, has increasingly been implicated as the plausible cause for marine mammal mortality and stranding events. However, despite extensive and lengthy investigations and continuing scientific research, definitive causes or links are rarely determined for the vast majority of marine mammal mass strandings and unusual morality events. It is generally more feasible to exclude causes of strandings or unusual mortality events than to resolve the specific causative factors leading to these events. For instance, although no definitive cause could be identified for the mass stranding and death of 26 short-beaked common dolphins (*Delphinus delphis*) in the Cornwall region of the United Kingdom during 2008, more than ten factors were excluded for were considered highly unlikely to have caused the stranding (Jepson and Deaville 2009). Ketten (2014) examined the linkage between mass strandings of marine mammals and exposure to military sonar and other high intensity acoustic sources and noted that, in absence of other causative factors, mid-frequency military sonar transmissions have been implicated as a causative factor in several marine mammal strandings in the Bahamas, Hawaii, the Canary Islands, Madeira, and Greece.

As a result of scientific investigations and research over the last decade, especially on beaked whales, the scientific understanding has increased regarding the association between behavioral reactions to natural as well as anthropogenic sources and strandings or deaths of marine mammals. Scientists suspect that for some species, particularly deep-diving marine mammals, behavioral reactions may begin a cascade of physiologic effects, such as gas and fat embolisms, that may result in injury, death, and strandings of marine mammals (Cox et al. 2006; Fernandez et al. 2005a; Zimmer and Tyack 2007).

Globally from 2006 through early 2010, at least 27 mass strandings of 11 marine mammal species occurred. These 27 mass stranding and mortality events were researched and analyzed to determine if any occurred within or near SURTASS LFA sonar mission areas, or if any were potentially associated with the transmission of underwater sound from military sonar. Any mass strandings involving beaked whales were also examined, as strandings of this species group have been shown to have a significant correlation with MFA naval sonar activities in some geographic regions (in the Mediterranean and Caribbean Seas but not off the coasts of Japan or Southern California) (Filadelfo et al. 2009). Additionally, marine mammal stranding records from Japan were analyzed for spatial or temporal correlations to LFA sonar operations. The use of SURTASS LFA sonar was not associated with any of the reported 27 mass stranding events or unusual mortality events that occurred globally between 2006 and early 2010. There is no evidence that LFA sonar transmissions resulted in any difference in the stranding rates of marine mammals in Japanese coastal waters adjacent to LFA sonar mission areas.

For all of the 2012 through 2017 reporting period, all available media and known stranding databases were monitored for strandings in or adjacent to the SURTASS LFA sonar operations for vessels in the western and central North Pacific Ocean and Indian Ocean mission areas. The Navy concluded that none of the stranding events reported in those areas occurred spatially and temporally with the SURTASS LFA sonar missions. NMFS concurs with Navy’s assessment. No SURTASS LFA sonar operations occurred in the Hawaii mission areas during the five-year period.

As documented above, the employment of LFA sonar is not expected to result in any sonar-induced strandings of marine mammals. Given the large number of natural factors that can result in marine mammal mortality, the high occurrence of marine mammal strandings, and the many years of LFA sonar operations without any reported associated stranding events (greater than 15 years), the likelihood of LFA sonar transmissions causing marine mammals to strand is negligible.

7.3.7 Potential Long-Term Consequences to the Individual and the Population

Long-term consequences to a population are determined by examining changes in the population growth rate. Individual effects that could lead to a reduction in the population growth rate include mortality or injury (that removes animals from the reproductive pool), hearing loss (which depending on severity could impact navigation, foraging, predator avoidance, or communication), chronic stress (which could make individuals more susceptible to disease), displacement of individuals (especially from preferred foraging or mating grounds), and disruption of socials bonds (due to masking of conspecific signals or displacement). However, the long-term consequences of any of these effects are difficult to predict because individual experience and time can create complex contingencies, especially for intelligent, long-lived animals like marine mammals. While a lost reproductive opportunity could be a measureable cost to the individual, the outcome for the animal, and ultimately the population, can vary. Any number of factors, such as maternal inexperience, years of poor food supply, or predator pressure, could produce a cost of a lost reproductive opportunity, but these events may be “made up” during the life of a normal healthy individual. The same holds true for exposure to human-generated noise sources. These biological realities must be taken into consideration when assessing risk, uncertainties about that risk, and the feasibility of preventing or recouping such risks. The long-term consequences or relatively trivial events like short-term masking of a conspecific’s social sounds, or a single lost feeding opportunity, can be exaggerated beyond its actual importance by focusing on the single event and not the important variable, which is the individual and its lifetime parameters of growth, reproduction, and survival.

Population models are well known from many fields in biology including fisheries and wildlife management. These models accept inputs for the population size and changes in vital rates of the population such as the mean values for survival age, lifetime reproductive success, and recruitment of new individuals into the population. The time-scale of the inputs in a population model for long-lived animals such as marine mammals is on the order of seasons, years, or life stages (e.g., neonate, juvenile, reproductive adult), and are often concerned only with the success of individuals from one time period or stage to the next. Unfortunately, information is not available to accurately assess the impact of acoustic exposure on individual marine mammal vital rates. Further, for assessing the impact of acoustic impacts to marine mammal populations, many of the inputs required by population models are not known.

Recently, efforts have been made to understand the linkage between a stressor, such as anthropogenic sound, and its immediate behavioral or physiological consequences for the individual, and then the subsequent effects on that individual’s vital rates (growth, survival, and reproduction), and the consequences, in turn, for the population. In 2005, a panel convened by the National Research Council of the United States National Academy of Sciences published a report on *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes*

Biologically Significant Effects. The panel developed what it called “a conceptual model” that outlined how marine mammals might be affected by anthropogenic noise and how population level effects could be inferred on the basis of observed behavioral changes. They called this model ‘Population Consequences of Acoustic Disturbance’ (PCAD). In 2009, the U.S. Office of Naval Research (ONR) set up a working group to transform this framework into a formal mathematical structure and determine how that structure could be parameterized using data from a number of case studies. The ONR working group extended the PCAD framework so that it could be used to consider other forms of disturbance and to address the impact of disturbance on physiology as well as behavior. Their current version of that framework is now known as Population Consequences of Disturbance (PCoD) (New et al. 2014). It is important to note that PCoD is ongoing and is an exploratory project to determine how an interim PCoD approach might inform analysis.

New et al. (2013) developed a mathematical model simulating a functional link between feeding energetics and a species’ requirements for survival and reproductions for 21 species of beaked whale. The authors report “reasonable confidence” in their model, although approximately 29 percent (six of 21 beaked whale species modeled) failed to survive or reproduce, which the authors attribute to possible inaccuracies in the underlying parameters. Based on the model simulation, New et al. (2013) determined that if habitat quality and “accessible energy” (derived from the availability of either plentiful prey or prey with high energy content) are both high, then survival rates are high as well. If these variables are low, then adults may survive but calves will not. For the 29 percent of beaked whale species for which the model failed (within the assumed range of current inputs), the assumption was a two-year calving period (or inter-calf interval). However, for species with longer gestation periods (such as the 17-month gestation period of Baird’s beaked whale [*Berardius bairdii*]), this inter-calf interval may be too short. For Blainville’s beaked whale, (Claridge 2013) has shown that calf age at separation is at least three years, and that the inter-calf interval at Abaco in the Bahamas may be four years. New et al. (2013) acknowledge that an assumed two-year calving period in the modeling may not be long enough to build up the energetic resources necessary for mother and calf survival.

As another critical model assumption, prey preferences were modeled based on stomach content analyses of stranded animals, which the authors acknowledge are traditionally poor estimates of the diets of healthy animals, as stranded animals are often sick prior to stranding. Stomach content remnants of prey species do not digest equally, as only the hard parts of some prey types remain (e.g., fish otoliths, beaks of cephalopods) and thus often provide an incomplete picture of diet. Given these unknowns are the failure of the simulation to work for 29 percent of beaked whale species, the modeled survival rates of all beaked whales, particularly those modeled with prey having low energy content, may be better than simulated if higher-energy prey makes up a larger part of the diet than assumed by the model simulations.

In short, for the model output New et al. (2013) created to correctly represent links between the species and their environment, that model must identify all the critical and relevant ecological parameters as input variables, provide the correct values for those parameters, and then the model must appropriately integrate modeling functions to duplicate the complex relationships the model intends to represent. If an assumption (model input) such as calving period or prey preferences is incorrect (and there is presently no way to know), then the model would not be representing what may actually be occurring. New et al. (2013) report that their simulations suggest that adults will survive but not reproduce if anthropogenic disturbances result in being displaced to areas of "impaired foraging." Underlying this suggestion is the additional unstated assumption that habitat capable of sustaining a beaked whale is limited in proximity to where any disturbance has occurred and there are not data to indicate that is a valid assumption.

While the New et al. (2013) model provides a test case for future research, this pilot study has very little of critical data necessary to form any conclusion applicable to current management decisions. The authors note the need for more data on prey species and reproductive parameters including gestation and lactation duration, as the model results are particularly affected by these assumptions. Therefore, any suggestion of biological sensitivity to the simulation's input parameters is uncertain.

New et al. (2014) used a simulation model to assess how behavioral disruptions (e.g., significant disruption of foraging behavior) may affect Southern elephant seal (*Mirounga leonina*) health, offspring survival, individual fitness, and population growth rate. They suggested their model can determine the population consequences of disturbance from short-term changes in individual animals. Their model assumed that disturbance affected behavior by reducing the number of drift dives in which the animals were feeding and increasing the time they spent in transit. For example, they suggested a disturbance lasting 50 percent of an average annual foraging trip would reduce pup survival by 0.4 percent. If this level of disturbance continued over 30 years and the population did not adapt, the authors found that the population size would decrease by approximately ten percent.

The findings of New et al. (2014) are not applicable to the temporary behavioral disruptions that may be caused by SURTASS LFA sonar for a number of reasons. First, the model assumed that individuals would be unable to compensate for lost foraging opportunities. As described previously, available empirical data does not confirm this would be the case. For example, elephant seals are unlikely to be affected by short-term variations in prey availability because they take long foraging trips, allowing for some margin of error in prey availability (Costa 1993), as cited in New et al. (2014). We expect the species 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 SURTASS LFA sonar 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 at a later time. Additionally, the behavioral disruption of ESA-listed species reasonably expected to occur due to the operation of SURTASS LFA sonar will not have as long of a duration as those considered in the New et al. (2014) study. No individual animals will be exposed to SURTASS

LFA sonar for a long enough duration to disrupt 50 percent of its annual feeding opportunities over multiple years. New et al. (2014) suggest it would be unlikely even for episodic environmental change, such as El Niño events, to affect the probability of population persistence. As suggested by the authors, the New et al. (2014) model may be more applicable to the consideration of potential long-term behavioral disruptions (e.g., those that may result from climate change).

In summary, it remains challenging to assess the relative biological significance of, and the potential for long term or population consequences to result from, short-term behavioral responses in marine mammals due to Navy sonar (Southall et al. 2016). While it is important to understand the ways in which behavioral responses may result in long-term impacts to individuals or populations, we do not yet have the data to underpin the link between behavioral response and population consequences (Harris et al. 2017). Until an appropriate quantitative model is developed and until all relevant empirical data is collected to support such a model for the species considered in this opinion, the best assessment of long-term consequences from Navy SURTASS LFA sonar operations will be to monitor marine mammal populations over time. A Navy workshop on Marine Mammals and Sound indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival. The Navy has developed monitoring plans for protected marine mammals and sea turtles occurring on Navy ranges with the goal of assessing the impacts of training and testing activities on marine species and the effectiveness of the Navy's current mitigation practices. All monitoring reports are available to the public and posted online at: www.navymarinespeciesmonitoring.us/.

7.3.8 Interaction of Active Sonar and Other Sound Sources

Several investigators and organizations have expressed concern about the "cumulative impact" (in the NEPA sense of the term) of marine sounds on the ocean environment and its organisms. Any man-made sound that is strong enough to be audible (detectable above natural background noise) will increase total background levels and could interfere with an animal's ability to detect sound signals if the signal is weak, relative to total noise levels. Concern about the cumulative impact of man-made sounds focuses on impacts from individual actions that are insignificant or minor when considered in isolation, but combine to produce effects that are greater than any individual action because the effects are either synergistic (effects that occur when two or more phenomena interact) multiplicative, or additive. In this opinion, our assessment has focused primarily on the effect of adding LFA sonar to underwater ambient noise levels, but also on the effect of adding MFA sonar and LFA sonar to underwater ambient noise levels during the same series of exercises.

Richardson et al. (1995e) provided extensive information and arguments about the potential cumulative effects of man-made noise on marine mammals. Those effects including masking, physiological effects and stress, habituation, and sensitization. Those concerns were echoed by Clark and Fristrup (2001b), The National Research Council (NRC 2003a), the National

Resources Defense Council (Jasny et al. 2005), and others. Although all of these responses have been measured in terrestrial animals reacting to airborne, mad-made noises, those studies are counterbalanced by studies of other terrestrial mammals that did not exhibit these responses to similar acoustic stimuli.

Broadband, continuous low-frequency shipping noise is more likely to affect marine mammals than narrowband, low duty cycle SURTASS LFA sonar. Moreover, SURTASS LFA sonar bandwidth is limited (approximately 30 Hz), the average maximum pulse length is 60 seconds, signals do not remain at a single frequency for more than ten seconds, and during an operation the system is off nominally 90 to 92.5 percent of the time. Most mysticetes vocalizations are in the low frequency band below one kHz. No direct auditory measurements have been made for any mysticete, but it is generally believed that their frequency band of best hearing is below 1,000 Hz, where their calls have the greatest energy (Clark 1990; Ketten 2000). However, with the nominal duty cycle of 7.5 to ten percent, masking would be temporary. For these reasons, any masking effects from SURTASS LFA sonar are expected to be negligible.

Odontocetes have a broad acoustic range and hearing thresholds measure between 400 Hz and 100 kHz (Finneran et al. 2002b; Richardson et al. 1995e). It is believed that odontocetes communicate above 1,000 Hz and echolocate above 20 kHz (Wursig and Richardson 2009). While the upward spread of masking is known to exist, the phenomenon has a limited range in frequency. Kidd (2007) showed that magnitude of the masking effect decreases as the difference between signal and masking frequency increase; i.e., the masking effect is lower at three times the frequency of the masker than at two times the frequency. Gorga et al. (2002) demonstrated that for a 1.2 kHz masking signal, the upward spread of masking was extinguished at frequencies of six kHz and higher. Therefore, while the phenomenon of upward spread of masking does exist, it is unlikely that LFA sonar would have any significant effect on the hearing of higher frequency animals. Gorga et al. (2002) also demonstrated that the upward spread of masking is a function of the received level of the masking signal. Therefore, a large increase in a masked bandwidth due to upward masking would only occur at high received levels of the LFA sonar signal.

As described previously, when combined with the naturally occurring and other man-made sources of noise in the oceans, the intermittent LFA sonar signals barely contribute a measurable portion of the total acoustic energy. In a report entitled *Ad-Hoc Group on the Impact of Sonar on Cetaceans*, the International Council for the Exploration of the Sea (ICES 2005) concluded that shipping accounts for more than 75 percent of all human sound in the sea, and sonar amounts to no more than ten percent of sound. It further stated that sonar (noise budget) will probably never exceed ten percent, but that sonar deployment seems likely to increase in the future.

In some instances, one or more of the vessels equipped with SURTASS LFA sonar would participate in Navy training exercises that involve anti-submarine warfare and MFA sonar. During these exercises, sound fields produced by LFA sonar might co-occur with sound fields generated by MFA sonar or animals might be exposed to LFA sonar and MFA sonar in a short-time interval. Potential interactions between LFA sonar and other sonars were analyzed in the Navy's FSEIS/SOEIS (Navy 2012a; Navy 2017b). Although the SURTASS LFA sonar and MFA sonar (AN/SQS 53C) are similar in the underlying transmission types, specifically frequency-modulated sweeps and continuous wave transmission, LFA sonar and MFA sonars are dissimilar in other respects. In addition to these multiple differences, the duty cycle (i.e., the amount of time during sonar operations that the sonar is actually transmitting), is different for SURTASS LFA sonar as opposed to MFA sonar. During SURTASS LFA sonar operations, LFA sonar transmits approximately ten percent of the time (one minute out of ten). During MFA sonar operations, MFA sonar transmits approximately 1.7 percent of the time (one second out of 60). This means that for any given period of time that both SURTASS LFA sonar and MFA sonars are operating concurrently, the LFA sonar 60 second transmission will be overlapped by one second of MFA transmission, or 1.7 percent of the 60-second LFA sonar ping (one second per 60 seconds).

The ocean volumes (MMPA Level B harassment) received levels for each source are relatively small. It is not reasonably foreseeable that SURTASS LFA sonar and MFA sonars would operate simultaneously within ranges less than 9.3 km (5 nmi). Thus, it is not reasonably foreseeable that the Level A Harassment volumes of the two sonars could ever overlap during simultaneous transmissions. Additionally, as described further in the FSEIS/SOEIS (Navy 2012a; Navy 2017b), concurrent MFA/SURTASS LFA sonar operations produce no Level B harassment risk greater than that obtained by simply adding the risks from the individual sources.

Because of the potential for seismic surveys to interfere with the reception of passive signals and return echoes, SURTASS LFA sonar operations are not expected to be close enough to the these activities to have any synergistic effects. Because of the differences between the LFA sonar coherent signal and seismic airgun impulsive "shots," there is little chance of producing a "synergistic" sound field. Marine animals would perceive these two sources of underwater sound differently and any addition of received signals would be insignificant. This situation would present itself only rarely, as LFA sonar training and testing operations have not been, and are not expected to be, conducted in proximity to any seismic survey activities.

If SURTASS LFA sonar operations were to occur concurrent with other military and commercial sonar systems, synergistic effects are not probable because of differences between these systems. In order for the sound fields to converge, the multiple sources would have to transmit exactly in phase (at the same time), requiring similar signal characteristics, such as time of transmissions, depth, frequency, bandwidth, vertical steering angle, waveform, wavetrain, pulse length, pulse repetition rate, and duty cycle. The potential for this occurring is small.

Therefore, because of major differences in signal characteristics between LFA sonar, MFA, and seismic airguns, there is negligible chance of producing a "synergistic" sound field. It is also unlikely that LFA sonar sources, if operated in proximity to each other would produce a sound field so complex that marine animals would not be able to escape.

7.4 Risk Assessment Framework – Sea Turtles

There are very few studies of the potential effects of underwater sound on sea turtles and most of these examined the effects of sounds of much longer duration or of different types (e.g., seismic airgun) than the SURTASS LFA sonar signals. The analysis of the potential effects on sea turtle species is summarized based on the following SURTASS LFA sonar operational parameters:

- Small number of SURTASS LFA sonar systems to be deployed;
- Geographic restrictions imposed on system employment;
- Narrow bandwidth of the SURTASS LFA sonar signal (approximately 30 Hz);
- Slowly moving ship, coupled with low system duty cycle, would mean that a sea turtle would spend less time in the LFA sonar mitigation and buffer zones (180 dB sound pressure level sound field); therefore, with a ship speed of less than 9 kph (five knots), the potential for animals being in the sonar transmit beam during the estimated 7.5 to 10 percent of the time the sonar is actually transmitting is very low; and
- Small size of the LFA sonar mitigation zone (180 dB sound pressure level sound field) relative to open ocean areas.

Due to the lack of more definitive data on sea turtle species or DPS distributions in the open ocean, it is not feasible to estimate the percentage of a species or DPS that could be located in a SURTASS LFA sonar operations area at a potentially vulnerable depth, during a LFA sonar sound transmission. Data on sea turtle sound production and hearing are very limited, although they are known to hear low frequency sound (Lavendar 2014; Martin et al. 2012).

7.4.1 Non-Auditory Injury

There is limited data on the potential for anthropogenic sound to cause injury in sea turtles, but direct injuries from SURTASS LFA sonar are unlikely because of the relatively lower peak pressures and slower rise times than potentially injurious sources such as explosives. Non-impulsive sources such as sonar also lack the strong shock wave such as that associated with an explosion. In their “Sound Exposure Guidelines for Sea Turtles and Fishes,” a technical report developed and approved by Accredited Standards Committee S3/SC 1 Animal Bioacoustics, Popper et al. (2014b) also concluded that the risk of sea turtles experiencing mortality, potential mortal injury, or recoverable injury was low from exposure to low-frequency sonar. For these reasons and the mitigation measures that will be implemented by the Navy when SURTASS LFA sonar is transmitting (e.g., shutdown if a sea turtle is detected within the 180 dB mitigation zone), we do not expect non-auditory injuries of sea turtles to occur.

7.4.2 Hearing Loss

Hearing loss could effectively reduce the distance over which sea turtles can detect biologically relevant sounds. Both auditory trauma (a direct injury discussed above) and auditory fatigue may result in hearing loss, but the mechanisms responsible for auditory fatigue differ from auditory trauma. Hearing loss due to auditory fatigue is also known as threshold shift, a reduction in hearing sensitivity at certain frequencies. Threshold shift is the difference between hearing thresholds measured before and after an intense, fatiguing sound exposure. Threshold shift occurs when hair cells in the ear fatigue, causing them to become less sensitive over a small range of frequencies related to the sound source to which an animal was exposed. The actual amount of threshold shift depends on the amplitude, duration, frequency, and temporal patterns of the sound exposure. No studies are published on inducing threshold shift in sea turtles; therefore, the potential for the impact on sea turtles is inferred from studies of threshold shift in other animals. Given sea turtles best underwater hearing range is from 100 to 400 Hz (Lavendar 2014; Martin et al. 2012), the potential exists for diving sea turtles to experience auditory effects from exposure to LFA sonar.

Permanent threshold shift is a permanent hearing loss at a certain frequency range. Permanent threshold shift is non-recoverable due to the destruction of tissues within the auditory system. The animal does not become deaf, but requires a louder sound stimulus (relative to the amount of PTS) to detect a sound within the affected frequencies. Temporary threshold shift is a hearing loss that recovers to the original hearing threshold over a period of time. An animal may not even be aware of a TTS. The animal does not become deaf, but requires a louder sound stimulus (relative to the amount of TTS) to detect a sound within the affected frequencies. Temporary threshold shift may last several minutes to several days, depending on the intensity and duration of the sound exposure that induced the threshold shift (including multiple exposures). There are no published scientific data on permanent or temporary loss of hearing in sea turtles caused by low frequency sound. In their *Sound Exposure Guidelines for Sea Turtles and Fishes*, a technical report developed and approved by Accredited Standards Committee S3/SC 1 Animal Bioacoustics, Popper et al. (2014b) determined that if a sea turtle was located far from the sound source, there was a low risk it could experience TTS, and a moderate risk if the animal was located intermediate or close distances to the source.

Navy (2017a) developed an auditory weighting function and an exposure function in sound exposure level (SEL) estimate onset TTS and PTS in sea turtles. Both functions estimate the most sensitive hearing of sea turtles at a frequency of approximately 170 Hz, with sensitivity decreasing rapidly at frequencies above and below. For SURTASS LFA sonar operating at frequencies between 100 and 500 Hz, the most protective calculations would utilize auditory weighting and thresholds at 170 Hz. Therefore, the threshold for onset TTS is 200 dB re: 1 μPa^2-sec and onset PTS is 220 dB re: 1 μPa^2-sec and would be weighted by 0 dB (Navy 2017a). To calculate the distance at which onset TTS and onset PTS might occur from exposure to SURTASS LFA sonar, the length of a nominal LFA transmission (60 seconds) should also be considered. If the assumption is made that all received levels are at the same sound pressure level received level (i.e., the animal and vessel remain at the same distance and depth from each other for an entire minute), the thresholds are lowered by approximately 18 dB ($10x\log_{10}$[60 seconds]=17.8). This results in sound pressure level thresholds for onset TTS and onset PTS of 182 dB re: 1 μPa and 202 dB re: 1 μPa, respectively. Based on simple spherical spreading (i.e., transmissions loss based on $20x\log_{10}$[range (m)]), sea turtles would need to be within 44 m [143 ft] or 4 m [14 ft], respectively, for the duration of an entire 60-seconds LFA transmission to experience onset TTS or onset PTS (Navy 2017b).

For sea turtles to experience auditory impacts, they would need to swim at approximately 3 knots for the 60-seconds signal of the SURTASS LFA sonar, to match its speed. This speed is faster than average swim speeds of sea turtles, but within the range of their fastest swim speeds. However, the HF/M3 active sonar mitigation measure is able to detect sea turtles within the 180 dB re: 1 μPa mitigation zone (Navy 2017b). It is unlikely that a sea turtle would remain within 44 m (143 ft) of the LFA sonar for an entire 60-seconds signal without being detected to experience TTS. It is even more unlikely that a turtle would be within 4 m (14 ft) of the LFA sonar to experience PTS. Therefore, the potential for SURTASS LFA sonar to cause TTS or PTS in sea turtles is negligible.

7.4.3 Masking

While no masking studies on sea turtles have been conducted, an indirect study looked at the potential for masking by examining sounds in an area known to be inhabited by sea turtles. These underwater sound recordings were made in one of the major coastal foraging areas for juvenile sea turtles (mostly green, Kemp’s ridley, and loggerhead sea turtles) in the Peconic Bay Estuary system in Long Island, New York (Samuel et al. 2005). The recording season of the underwater environment coincided with the sea turtle activity season in an inshore area where there is considerable boating and recreational activity, especially during the July to September timeframe. During this time period, received levels at the data collection hydrophone system in the 200 to 700 Hz band ranged from 83 dB re: 1 µPa (rms) up to 113 dB re: 1 µPa (rms). Therefore, during much of the season when sea turtles are actively foraging in New York waters, they are undoubtedly exposed to these levels of noise, most of which is anthropogenic. However, there were no data collected on any behavioral changes in the sea turtles as a consequence of anthropogenic noise or otherwise during this study, so it cannot be stated whether this level of ambient sound would have any physiological and/or behavioral effects on the sea turtles.

Sound likely plays a limited role in a sea turtle’s environment as described above in section 7.4.2. Also, as also noted in section 7.3.5, the operation of SURTASS LFA sonar is not expected to result in extended period of time where masking could occur. At a maximum 20 percent duty cycle for SURTASS LFA sonar (but an average of 7.5 percent), it is anticipated that any masking would be temporary (i.e., at least 80 percent of the time an animal would be able to perceive incoming signals through low frequency sounds). The possibility of effective masking would only occur for environmental sounds that happen during the ping transmission (maximum 100 seconds) and are at, or at least close to, the frequencies in the 30 Hz wide bandwidth signal, during the ten seconds the SURTASS LFA sonar was transmitting in that bandwidth. This indicates biological relevant sounds for individuals in close proximity would only be masked for this short, intermittent, period of time. Furthermore, SURTASS LFA sonar missions are geographically and temporally dispersed. Additionally, the geographical restrictions imposed on all SURTASS LFA sonar operations would limit the potential for masking of sea turtles in the vicinity of their terrestrial nesting sites. These factors reduce the likelihood of sources causing significant auditory masking in sea turtles. As a result, the available evidence does not lead us to expect masking to reduce the reproduction, numbers, or distribution of threatened or endangered sea turtles.

7.4.4 Physiological Stress

Sea turtles may exhibit a behavioral response or combinations of behavioral responses upon exposure to anthropogenic sounds. If a sound is detected, a stress response (i.e., startle or annoyance) or a cueing response (based on a past stressful experience) can occur. Sea turtles naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with members of the same species, nesting, and interactions with predators all contribute to stress. Anthropogenic activities could provide stressors in addition to those that occur in the absence of human activity.

Immature Kemp’s ridley sea turtles show physiological responses to the acute stress of capture and handling through increased levels of the stress hormone corticosterone, along with biting and rapid flipper movement (Gregory and Schmid 2001). We would expect the other sea turtle species considered in this opinion to have a similar physiological stress response. Captive olive ridley hatchlings showed heightened blood glucose levels indicating physiological stress (Zenteno et al. 2008). Repeated exposure to stressors, including human disturbance such as from vessel noise and other anthropogenic sound, may result in negative consequences to the health and viability of an individual or population (Gregory and Schmid 2001). Factors to consider when predicting a stress or cueing response is whether an animal is naïve or has prior experience with a stressor. Prior experience with a stressor may be particular importance as repeated experience with a stressor may dull the stress response via acclimation (Hazel et al. 2007).

7.4.5 Behavioral Reactions

Little is known about the hearing ability of sea turtles and their response to acoustic disturbance. The response of a sea turtle to an anthropogenic sound will depend on the frequency, duration, temporal pattern, and amplitude of the sound, as well as the animal’s prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away could also affect the way a sea turtle responds. Potential behavioral responses to anthropogenic sound could include startle reactions, disruption of feeding, disruption of migration, changes in respiration, alteration of swim speed, alteration of swim direction, and area avoidance.

Sea turtles can travel many kilometers per day in the open ocean, as shown in tagging studies (Luschi et al. 2003a; Papi et al. 1995); and the use of magnetic positional information for long-range navigation has been demonstrated in several diverse animals, including sea turtles (Benhamou et al. 2011; Lohmann et al. 2012). Sea turtles make extensive migrations and movements either for foraging opportunities or to breed. Their migration tracks may extend to thousands of kilometers (Allen 2007; Arendt et al. 2012; Luschi et al. 2006; Shillinger et al. 2008).

Changes in movement patterns or other behaviors due to exposure to a high intensity sound source that causes prolonged displacement of animals from the site of their normal activities could be considered a deleterious effect. Displacement can occur in two dimensions: vertical and horizontal. For example, a sea turtle could move to the surface, where anthropogenic low frequency sound would be weaker, possibly exposing it to a higher degree of predation. As for horizontal displacement, this is probably of greatest importance for non-pelagic sea turtle species (green, hawksbill, olive ridley), for which displacement from preferred benthic habitats could be construed as more serious.

Behavioral responses to human activity have been investigated for only a few species of sea turtles: green and loggerhead (McCauley et al. 2000; O'Hara and Wilcox 1990); and olive ridley, leatherbacks, loggerhead, and 160 unidentified sea turtles (hard-shell species) (Weir 2007). The work by O’Hara and Wilcox (1990) and McCauley et al. (2000) reported behavioral changes of sea turtles in response to seismic airguns. O’Hara and Wilcox (1990) reported avoidance behaviors by loggerhead sea turtles in response to airguns with sound levels (received level) of 175 to 176 dB re: 1 µPa (peak-to-peak). McCauley et al. (2000) reported noticeable increase in swimming behavior for both green and loggerhead sea turtles at received levels of 166 dB re: 1 µPa (peak-to-peak). At 175 dB re: 1 µPa (peak-to-peak) received level, both green and loggerhead sea turtles displayed increasingly erratic behavior (McCauley et al. 2000). In their “Sound Exposure Guidelines for Sea Turtles and Fishes,” a technical report developed and approved by Accredited Standards committee S3/SC1 Animal Bioacoustics, Popper et al. (2014b) determined that the relative risk of sea turtles responding behaviorally to low-frequency sonar is low, regardless of the distance from the source.

It is also possible that behavioral reactions could lead to negative physiological consequences. For example, Garcia-Parraga et al. (2014) reported evidence of decompression sickness (e.g., gas embolism) in sea turtles following capture in trawls or gillnets, with a higher incidence of decompression sickness when caught in deeper waters. A sea turtle could have an extreme behavioral avoidance reaction (e.g., surfacing too quickly in an attempt to avoid noise) that could lead to decompression sickness-like symptoms and fitness consequences. However, previous research was suggested sea turtles are protected against decompression sickness through anatomical, physiological, and behavioral adaptations (Berkson 1967; Castellini 2012; Fossette et al. 2010; Lutcavage and Lutz 1997; Piantadosi and Thalmann 2004). Given this uncertainty in the available literature and the lack of evidence that this sort of extreme behavioral avoidance reaction would be expected from exposure to SURTASS LFA sonar, we do not believe such a reaction is likely to occur and we do not consider decompression sickness in sea turtles further in this opinion.

Based on the hearing data, if a sea turtle happened to be in proximity of a SURTASS LFA sonar operations area, it could hear the low frequency transmissions. However, given that the majority of sea turtles encountered would probably be transiting in the open ocean from one site to another, the possibility of significant displacement would be unlikely.

7.5 Mitigation to Minimize or Avoid Exposure

The Navy proposes several mitigation and monitoring measures to reduce or eliminate the likelihood of exposing marine mammals to LFA sonar transmissions at high decibel levels including a monitoring program (visual monitoring, passive acoustic monitoring, and the HF/M3 active acoustic sonar system), delay/suspension protocols for LFA sonar transmissions, and geographic constraints on the use of SURTASS LFA sonar (coastal mitigation, LFA sonar mitigation and buffer zones, OBIAs, and avoidance of known recreational and commercial dive sites). Below we assess the available information on the effectiveness of the Navy’s proposed mitigation measures to minimize adverse effects to ESA-listed species from the proposed action. The Navy states that the employment of the combination of three mitigation monitoring measures at sea results in a predicted effectiveness nearing 100 percent within the 180 dB LFA sonar mitigation zone (Navy 2001a; Navy 2001b; Navy 2007; Navy 2012a; Navy 2017b).

7.5.1 Mitigation and Buffer Zone

Inside the LFA sonar mitigation and buffer zones during a ping, ESA-listed species could be exposed to sound levels at or above 174 dB and could experience PTS or more serious injury. However, the LFA sonar mitigation and buffer zones were established and designed to prevent marine mammal or sea turtles from being exposed to energy levels high enough to produce these outcomes. Several aspects of the LFA sonar mitigation and buffer zones reduce an ESA-listed species’ chances of being exposed to LFA sonar at sound pressure levels at or above 180 dB; (a) the mitigation zone extends approximately 0.75 to 1 km (0.4 to 0.5 nmi) from the transmitters (to received levels of 180 dB) and is supplemented by a one-km buffer zone (where received levels are 174 dB); (b) the detection probabilities associated with the HF/M3 sonar (based on a single ping) exceed 95 percent for small dolphins at about 750 m (2,460 ft), whale calves at 1,000 m (3,281 ft) and large whales at more than 1,500 m (44,921 ft); (c) during actual operations marine mammals or larger sea turtles will receive approximately five pings from the HF/M3 sonar before entering the 180 dB mitigation zone with the probability of detection approaching 100 percent; (d) the depth of the LFA sonar transmitters would reduce the risk of exposing animals located near the ocean’s surface or in the mixed layer; and (e) marine mammals and larger sea turtles have a high probability of being detected within the LFA sonar mitigation and buffer zones and, as a result, a low probability of being exposed to sound pressure levels greater than 174 or 180 dB re: 1 µPa (rms) at 1 m.

For an animal to be exposed to LFA sonar transmissions at sound pressure levels greater than 180 dB, the animal would have to enter the LFA sonar mitigation and buffer zones without being detected by marine mammal observers or the HF/M3 sonar system and would have to remain in the LFA sonar mitigation and buffer zones when LFA sonar transmitters were operating. The monitoring results of the deployments of the SURTASS LFA sonar system from 2002 through May of 2013 suggest this is unlikely to occur. From 2002 through 2017, the active acoustic monitoring (HF/M3 sonar) resulted in a total of 190 possible marine mammals/sea turtle contacts that resulted in suspensions of operations in accordance with the terms and conditions of the existing permit. From August 2012 through November 2016, a total of 51 active acoustic monitoring resulted in a total of 51 detections during the 44 missions of the four SURTASS LFA sonar vessels. No contacts were reported within the 180 dB LFA sonar mitigation zone during transmissions, which suggests that no marine mammals were subjected to LFA sonar exposures that might have resulted in injuries. It is possible that a very small percentage of animals went undetected (particularly smaller sea turtles), but monitoring information does not suggest this is likely.

In prior SURTASS LFA sonar rulemakings, the 180 dB mitigation zone was designed to reduce or alleviate the likelihood that marine mammals are exposed to levels of sound that may result in injury (PTS). NMFS’ 2016 *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (NOAA Technical Memorandum NMFS-OPR-55) presents the auditory weighting functions developed for each marine mammal hearing group that reflect the best available data on hearing, impacts of noise on hearing, and data on equal latency. When estimating the onset of injury (PTS), the NMFS 2016 marine mammal acoustic guidance defines weighted thresholds as sound exposure levels (Table 43). To determine what the sound exposure level for each hearing group would be when exposed to a 60-second (length of a nominal LFA transmission or 1 ping), 300 Hz (the center frequency in the possible transmission range of 100 to 500 Hz) SURTASS LFA sonar transmission, the auditory weighting functions must be applied to account for each hearing group’s sensitivity. Applying the auditory weighting functions to the nominal LFA sonar signal results in the thresholds increasing by approximately 1.5, 46, 56, 15, and 20 dB for low frequency, mid-frequency, high frequency, phocids underwater, and otariids underwater groups, respectively. Based on simple spherical spreading (i.e., transmission loss based on $20 \times \log_{10}$ [range {m}]), all hearing groups except low frequency cetaceans would need to be within 7 m (22 ft) for an entire LFA sonar ping (60 seconds) to potentially experience PTS. Low frequency cetaceans would be at the greatest distance from the transmitting sonar before experiencing the onset of injury, 41 m (135 ft) for this example. Consequently, the distance at which SURTASS LFA sonar transmissions will be mitigated is greater than the PTS distance associated with low frequency cetaceans. Any mitigation measure developed for low frequency cetaceans would be even more protective for any other marine mammals potentially exposed to SURTASS LFA sonar transmissions.

The following calculations illustrate what sound pressure level received level would be at the distance an low frequency cetacean would begin to experience PTS from transmitting LFA sonar. Per NMFS (2016) acoustic guidance, the low frequency cetacean threshold is 199 dB re: 1 μPa^2-second (weighted). The magnitude of the auditory weighting function at 300 Hz for SURTASS LFA sonar is 1.5 dB, with the equivalent unweighted SEL_{cum}[5] value of 200.5 dB re: 1

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[5] SEL_{cum}=cumulative sound exposure level

µPa^2-second. To convert this value into an sound pressure level value, total duration of sound exposure is needed:

$$\text{SPL} = \text{SEL}_{\text{cum}} - 10 \text{ x } \log_{10}(T)$$

Where T is the duration in seconds.

Applying the duration of a single ping of SURTASS LFA sonar, or 60 seconds, would result in 17.8 dB being subtracted from the unweighted cumulative SEL value of 200.5 dB, for an sound pressure level of 182.7 dB re: 1 µPa (rms). The mitigation distance to the 182.7-dB re: 1 µP (rms) isopleth would be somewhat smaller than that associated with the previously used 180 dB re: 1 µPa (rms) isopleth. If an low frequency cetacean was exposed to two full pings (60 seconds each) of SURTASS LFA sonar, the resulting sound pressure level would be 179.7 dB re: 1 µPa (rms). This exposure is unlikely, as a marine mammal would have to be close to the LFA sonar array (within 41 m [135 ft]) for an extended period, approximately 20 minutes, to experience two full pings.

The received level in this unlikely scenario (179.7 dB re: 1 µPa [rms]) is very close to the 180 dB re: 1 µPa (rms) received level on which previous mitigation measures for SURTASS LFA sonar have been based. As mentioned above, the Navy proposes to retain the current mitigation basis for SURTASS LFA sonar transmissions as the distance to the 180 dB re: 1 µPa (rms) isopleth. In the past, this mitigation zone was designed to reduce or alleviate the likelihood that marine mammals are exposed to levels of sound that may result in injury (PTS). However, due to the revised criteria in the NMFS 2016 marine mammal acoustic guidance, this mitigation zone precludes not only PTS, but also almost all TTS and more severe behavioral reactions. Thus, while not an expansion of the mitigation zone, this measure is now considered more effective at reducing a broader range of impacts compared to prior authorizations.

7.5.2 Visual Monitoring

The effectiveness of visual monitoring is limited to daylight hours, and its effectiveness declines during poor weather conditions and high Beaufort sea state. Visual monitoring methods for marine mammals or sea turtles only detect a fraction of those animals present since they can only be detected visually during the relatively short period when they are present at the sea surface (Mellinger and Barlow 2003). Also, visual monitoring is highly variable due to the nature of many cetaceans to form large groups and to relatively limited spatial and temporal scales of occurrence. In line transect surveys, the range of visual sighting effectiveness (distance from the ship's track, called effective strip width) varies with an animal's size, group size, reliability of conspicuous behaviors (blows), pattern of surfacing behavior, and positions of the observers (which includes the observer's height above the water surface). For most large baleen whales, effective strip width can be about 3 km (1.6 nmi) up through Beaufort sea state six (Buckland and Borchers 1993). For harbor porpoises the effective strip width is about 250 m (820 ft), because they are much smaller and less demonstrative on the surface than the baleen whales (Palka 1996). The percentage of animals that will pass unseen is difficult to determine, but minke whales, Schweder et al. (1992) estimated that visual survey crews did not detect about half of the animals in a strip width. Palka (1996) and Barlow (1988) estimated that visual survey teams did not detect about 25 percent of the harbor porpoises in a strip width. Given the limitations of visual monitoring, the Navy estimated that the effectiveness of visual monitoring for marine mammals or sea turtles at the sea surface is approximately nine percent (DoN 2001). Visual detections of marine mammals during SURTASS LFA sonar missions from 2002 through 2017 totaled 28 sightings. Throughout the 44 SURTASS LFA sonar missions conducted between August 2012 through November 2016, 15 visual detections of whales, dolphins, a sea turtle, unidentified species, and two schools of tuna resulted from visual monitoring by civilian observers.

7.5.3 Passive Acoustic Monitoring

Passive acoustic monitoring is only effective when marine mammals (particularly cetaceans) are vocalizing or calling underwater. The effectiveness of detection of some marine mammals by passive acoustic monitoring is considered to be higher than visual monitoring. Thomas et al. (1986) and Clark and Fristrup (1997) concluded that the effective strip width and detection rates for passive acoustic monitoring is greater than that for visual monitoring, but the percentage of animals that will be undetected by the methods is unknown. In joint, dedicated, visual and passive acoustic surveys for marine mammals, ten times as may cetacean groups were detected by passive acoustic methods compared to visual methods only (Barlow and Taylor 2005; McDonald and Moore 2002a; Rankin et al. 2007; Sirovic et al. 2004). Passive acoustic monitoring using the SURTASS passive acoustic array is primarily effective in the same frequency range in which the LFA sonar transmits (100 to 500 Hz). This would increase the detection rate of gray, humpback, fin, sei, Bryde's, and blue whales. The percentage of marine mammals that are undetected by passive acoustic monitoring is unknown. Detections from passive acoustic monitoring of marine mammals during SURTASS LFA sonar missions from 2002 through 2017, totaled 87 detections.

7.5.4 Active Acoustic Monitoring – High Frequency/Marine Mammal Monitoring Sonar

The HF/M3 active sonar system is the most effective measure the Navy uses to detect animals within two km (1.1 nmi) of the projectors. It is capable of operating in all weather conditions and Beaufort sea states as well as daylight and nighttime hours. The Navy developed the HF/M3 active sonar system due to the limitations of visual monitoring and passive acoustic monitoring. Qualitative and quantitative assessments of the HF/M3 system's ability to detect marine mammals of various sizes were verified in 170 hours of at-sea testing. The at-sea testing showed that several detections of a marine mammal by the HF/M3 sonar system would occur before a marine mammal entered the LFA mitigation zone (DoN 2001). Ellison and Stein (2001) reported that the detection probability would be near 100 percent for a medium-sized (10 m [33 ft]) marine mammal swimming towards the system. If the HF/M3 system detects animals within the LFA sonar mitigation or buffer zones, the projectors would be shut-down until the animal(s) move out of the mitigation and buffer zones. Combined with the visual monitoring and passive acoustic monitoring protocols, this minimizes the risk of marine mammals being exposed to sound pressure levels at or above 180 dB re: 1 µPa (rms) at 1 m.

The HF/M3 active sonar system monitoring detected 190 marine mammals during SURTASS LFA sonar missions from 2002 through 2017, and each of these detections resulted in the delay or suspension of SURTASS LFA sonar transmissions. The Navy followed the appropriate protocols and LFA sonar transmissions were suspended or delayed due to mitigation protocols. As a result, marine mammals that have been detected were not exposed to sonar transmissions at received levels above 180 dB.

The HF/M3 system also increases the likelihood of detecting sea turtles and large fish, such as sturgeon and sharks. Because the HF/M3 sonar is positioned at the top of the LFA sonar vertical array, sea turtles, sturgeon, and scalloped hammerhead sharks would first have to swim through the one-km HF/M3 sonar detection zone (i.e., the very same one-km buffer zone for marine mammals) where detection is highly likely, before entering the LFA sonar mitigation zone. This minimizes the likelihood of these species entering the LFA sonar mitigation zone.

The HF/M3 sonar ramp-up decreases the likelihood an ESA-listed marine species would be exposed to high sound pressure levels from the HF/M3 system itself. Benda-Beckmann et al. (2014) investigated the effectiveness of ramp-up procedures in reducing the area within which changes in hearing thresholds can occur. They modeled the level of sound killer whales were exposed to during a generic sonar operation preceded by different ramp-up schemes. Results indicate that ramp-up procedures reduced the risk of killer whales receiving sounds of sufficient intensity to affect their hearing. The main factors that limited effectiveness of ramp-up in a typical anti-submarine warfare scenario were high source level, rapid moving sonar source, and long silences between consecutive sonar transmissions.

7.5.5 Coastal Restrictions and Offshore Biologically Important Areas for Marine Mammal Restrictions

The SURTASS LFA sonar system would be operated in a manner that would not cause sonar sound fields to exceed 180 dB re: 1 µPa (rms) within the 22 km (12 nmi) coastal standoff range. In addition, the LFA sonar fields will not exceed 180 dB re: 1 µPa (rms) in an OBIA or within the one-km buffer zone seaward of any OBIA boundary during biologically important seasons. We expect this mitigation will be effective at reducing exposure to, and potential impacts to marine mammals from, SURTASS LFA sonar by avoiding higher densities of many species that may be found in coastal areas; avoiding high-level sounds in the vicinity of geographical features that have been associated with some stranding events; avoiding known human recreational and commercial dive sites to protect human divers and marine mammals located in the vicinity of known dive sites; and avoiding areas where these animals are known to conduct important activities (e.g., migrating, breeding and calving, feeding).

7.5.6 Annual Take Limit on Marine Mammals

The Navy will plan all SURTASS LFA sonar missions, regardless of the number of SURTASS LFA sonar vessels operating, to ensure that no more than 12 percent of any marine mammal species or stock will be taken by Level B harassment as that term is defined under the MMPA and annually from all SURTASS LFA sonar transmissions on all four vessels. During the 2012 through 2017 period (up to April 2017), the Navy's estimates of marine mammal species, stocks, or DPSs taken by Level B harassment under the MMPA never exceeded 6.4 percent annually. Monitoring reports from previous years of SURTASS LFA operations indicate that the Navy typically transmits LFA sonar well below the authorized number of hours and the actual percentages of affected marine mammal species, stocks, or DPSs are well below the 12 percent cap for Level B harassment for each stock.

7.6 Exposure and Response Analysis

As described previously, this opinion considers the Navy's proposed action to employ SURTASS LFA sonar routine training, testing, and military operations on four vessels in non-polar regions of the world's ocean for a five year period from August 2017 through August 2022 as well as on an annual period during 20 nominal missions in 15 mission areas of the western and central North Pacific Ocean and Indian Ocean for no more than 255 hours of SURTASS LFA sonar transmissions per vessel, in a manner consistent with the mitigation, monitoring, and reporting measures described in section 2.1.6 of this opinion. We also assumed that the activities proposed for the period of August 2017 through August 2018, and the period of the five-year (2017 through 2022) proposed action would continue into the reasonably foreseeable future at levels and locations similar to that described in this opinion. This approach addresses the court decision in *Intertribal Sinkyone Wilderness Council v. National Marine Fisheries Service et al.*, No. 1:12-cv-00420-NJV (N.D. Ca. September 25, 2013).

Our exposure and response analysis for the first year of the proposed action specifies the amount of take by Level B harassment, as defined under the MMPA, that is reasonably certain to occur for the period from August 2017 through August 2018. Because the locations of Navy SURTASS LFA sonar operations have changed minimally over time, our exposure and response analysis assumes that future take will occur, by Level B harassment, in the same mission areas and at levels no higher than proposed in the Navy's biological evaluation (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels). The exposure and response analysis below also considers incidental take of ESA-listed sea turtles from Navy SURTASS LFA sonar operations.

7.6.1 Exposure Analysis

Here we estimate the potential exposure of ESA-listed species to the only stressor associated with the proposed action we determined is likely to adversely affect ESA-listed species. For the reasons provided in section 6.1, this exposure analysis only addresses exposure to signals generated by SURTASS LFA sonar. Our analyses consider the intensity of received levels, the duration of a potential exposure, and how frequently individuals of an ESA-listed species might be exposed at different received levels. We assumed that exposure to SURTASS LFA sonar, regardless of the sound pressure level, is a pre-requisite for ESA-listed species to be adversely affected by the sonar.

This section describes the conditions under which ESA-listed species could be exposed to LFA sonar based on evaluations of the available information and also describes potential relationships between differing levels of exposure to LFA sonar and potential effects on ESA-listed species. Therefore, we assume that the potential biological risk associated with exposure to LFA sonar is a function of an animal's exposure to a sound and their response to that exposure, that could adversely affect the animal's hearing, behavior, psychology, or physiology.

As described previously, the LFA sonar system consists of up to 18 low-frequency acoustic-transmitting projectors that are suspended from a cable beneath a ship. The source level of an individual projector in the LFA sonar array is approximately 215 dB, and the sound field of the array can never have a sound pressure level higher than that of an individual projector. The typical LFA sonar signal is not a constant tone, but is a transmission of various signal types that vary in frequency and duration (including continuous wave and frequency-modulated signals). The Navy refers to a complete sequence of sound transmissions as a "ping" which can range from between six and 100 seconds, with no more than ten seconds at a frequency. The time between pings will typically range from six to 15 minutes. The Navy has stated that the duty cycle (the ratio of sound "on" time to total time) would not be greater than 20 percent. Based on operations since 2003, the average duty cycle for the LFA sonar system has been ten percent (Navy 2012a; Navy 2016; Navy 2017b).

7.6.1.1 *Intensity*

Sound transmissions are usually measured in terms of sound pressure levels, which are denoted as decibels and which have a reference pressure value of 1 µPa. The logarithmic nature of the dB scale means that each ten dB increase is a ten-fold increase in power (e.g., 20 dB is a 100-fold increase, 30 dB is a 1,000-fold increase). Humans perceive a ten dB increase in noise as a doubling of sound level, or a ten dB decrease in noise as a halving of sound level.

Inside the LFA sonar mitigation zone during a ping, a marine mammal could be exposed to sound levels at or above 180 dB re: 1 µPa (rms) at 1 m and could experience PTS other injury (see section 7.5.1 for a discussion on how the 180 dB mitigation zone relates to thresholds for PTS). However, implementing the LFA sonar mitigation and buffer zones, which are approximately 2 km (1.1 nmi) around the vessel, will ensure that no marine mammals are exposed to a sound pressure level greater than approximately 175 dB re: 1 µPa. Given the size of the LFA sonar mitigation zone (extending to approximately 0.75 to 1 km [0.4 to 0.6 nmi]) from the transmitter and the additional 1 km buffer zone, the detection probabilities associated with the HF/M3 sonar (above 95 percent probability of detecting small dolphins at about 750 m [0.4 nmi], whale calves at 1,000 m [0.6 nmi], and large whales at more than 1,500 m [0.8 nmi]), and the depth of the transmitters, a marine mammal would have a high probability of being detected within the LFA sonar mitigation and buffer zones and, as a result, a low probability of being exposed to sound levels greater than 180 dB re: 1 µPa (rms) at 1 m. For an animal to be exposed at received levels greater than 180 dB re: 1 µPa (rms), the animal would have to occur in the same approximately one km radius 180 dB re: 1 µPa (rms) sound field of the LFA sonar transmit array (entered at approximate depth of 122 m [400 ft]), would have to enter without being detected, and would have to remain there when the LFA sonar transmitter was operating. Based on the available information, we believe the probability of all of these events occurring, although possible, is extremely improbable. Further, SURTASS LFA sonar will be operated to ensure that sonar sound fields do not exceed 180 dB re: 1 µPa (rms) within 22 km (12 nmi) of any coastline, including offshore islands, or designated offshore areas that are biologically important for marine mammals outside the 22 km (12 nmi) zone during seasons specified for a particular area.

Thus far, the combination of monitoring and mitigation measures (including shut-down procedures) appear to have prevented most ESA-listed species of marine mammals and sea turtles from being exposed to SURTASS LFA sonar at received levels exceeding 180 dB (Navy 2016; Navy 2017b; Navy 2017c). Further, the implementation of geographic restrictions (i.e., coastal and dive sites as well as OBIAs for marine mammals) have prevented ESA-listed species from being exposed in some areas that are critical to their ecology, critical to large portions of their populations, or both. The Navy proposes to continue using these measures in the prescribed manner. Therefore, based on the evidence available, we conclude that it would be very unlikely for an ESA-listed marine animal to experience PTS because we do not expect individuals to be exposed to received levels of LFA sonar at or above 180 dB re: 1 µPa (rms).

7.6.1.2 *Exposure Duration*

The Navy proposes to conduct SURTASS LFA sonar routine testing, training, and military operations on up to four vessels for 240 days each year. The maximum time of active sonar transmission per vessel would be 255 hours each year. The duration of a typical SURTASS LFA sonar ping would range from six to 100 seconds, with no more than ten seconds at a single frequency; intervals between pings would range from six to 15 minutes. Pings would consist of various signal types that vary in frequency (between 100 and 500 Hz) and duration (including continuous wave and frequency-modulated signals). When the system is turned off, no additional energy would enter the ocean’s environment. The duration of an animal’s exposure to SURTASS LFA sonar signals will depend on their proximity to the transmitter and their location in the water column. Because of the length of individual pings, individual animals could be exposed to SURTASS LFA sonar transmissions for periods ranging from six to 100 seconds at a time (at sound pressure levels less than 180 dB), though this assumes the animal would not move away from the sound source in order to avoid exposure.

7.6.1.3 *Exposure Frequency*

Individual animals or groups of animals have a low probability of being exposed to SURTASS LFA sonar signals on multiple, separate occasions. The number of times an animal could be exposed to sound from SURTASS LFA sonar transmissions will depend on the deployment schedule for SURTASS LFA sonar vessels and the movement patterns of individual animals.

Some individuals may be exposed to multiple anthropogenic sound-producing activities over a season, year, or life stage. Repeated exposure to acoustic and other anthropogenic stimuli has been studied in several cases, especially as related to vessel traffic and whale watching. Common dolphins (*Dephinus* spp.) in New Zealand responded to dolphin-watching vessels by interrupting foraging and resting bouts, and took longer to resume behaviors in the presence of the vessel (Stockin 2008). Bejder et al. (2006a) studied responses of bottlenose dolphins to vessel approaches and found shorter lasting reactions in populations exposed to higher levels of vessel traffic. The authors indicated that lesser reactions in populations of dolphins regularly subjected to high levels of vessel traffic could be a sign of habituation, or it could be that the more sensitive animals in this population previously abandoned the area of higher human activity.

Marine mammals exposed to high levels of human activities may leave the area, habituate to the activity, or tolerate the disturbance and remain in the area. Individual marine mammals that are more tolerant may stay in a disturbed area, whereas individuals that are more sensitive may leave for areas with less human disturbance. Animals that remain throughout the disturbance may be unable to leave the area for a variety of physiological or environmental reasons. However, given the highly migratory, wide-ranging life histories, and open ocean environments of the species considered at risk in this consultation, we do not believe animals will remain in the immediate area of SURTASS LFA sonar operations. Longer-term displacement can lead to changes in abundance or distribution patterns of the species in the affected region if they do not become acclimated to the presence of the sound (Bejder et al. 2006b; Blackwell et al. 2004b; Teilmann et al. 2006). For example, gray whales in Baja California abandoned a historical breeding lagoon in the mid-1960s due to an increase in dredging and commercial shipping operations. Whales did not repopulate the lagoon after shipping activities had ceased for several years (Bryant et al. 1984). Over a shorter time scale, studies on the Atlantic Undersea Test and Evaluation Center instrumented range in the Bahamas have shown that some Blainville's beaked whales may be resident during all or part of the year in the area, and that individuals may move off of the range for several days during and following a sonar event. However animals are thought to continue feeding at short distances (a few kms) from the range out of the louder sound fields (less than 157 dB re: 1 μPa) (McCarthy et al. 2011; Tyack et al. 2011). Mysticetes in the northeast tended to adjust to vessel traffic over a number of years, trending towards more neutral responses to passing vessels (Watkins 1986) indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. Nevertheless, the long-term consequences of these habitat utilization changes are unknown, and likely vary depending on the species, geographic areas, and the degree of acoustic or other human disturbance.

Moore and Barlow (2013) have noted a decline in beaked whales in a broad area of the Pacific Ocean area out to 556 km (300 nmi) from the coast and extending from the Canadian-U.S. border to the tip of Baja Mexico. There are scientific caveats and limitations to the data used for that analysis, as well as oceanographic and species assemblage changes not thoroughly addressed in Moore and Barlow (2013), although the authors suggest Navy MFA sonar as one possible explanation for the apparent decline in beaked whale numbers over that broad area. In the small portion of the Pacific coast overlapping the U.S. Navy's Southern California Range Complex, long-term residency by individual Cuvier's beaked whales and documented higher densities of beaked whales provide indications that the proposed decline in numbers elsewhere along the Pacific coast is not apparent where the Navy has been intensively training with MFA sonar and other systems for decades. While it is possible that a downward trend in beaked whales may have gone unnoticed at the range complex (due to a lack of survey precision) or that beaked whale densities may have been higher before the Navy began using MFA sonar more than 60 years ago, there are no data available to suggest that beaked whale numbers have declined on the range where Navy sonar use has routinely occurred. As Moore and Barlow (2013) point out, it remains clear that the Navy range in southern California continues to support high densities of beaked whales. Furthermore, a large part of the U.S. West Coast action area used by Moore and Barlow (2013) in their assessment of possible reasons for the decline include vast areas where the Navy does not conduct in-water training with MFA sonar.

Establishing a causal link between anthropogenic noise, animal communication, and individual impacts, as well as population viability, is difficult to quantify and assess (McGregor 2013; Read et al. 2014a). Assessing the effects of sounds, both individually and cumulatively, on marine species is difficult because responses depend on a variety of factors including age class, prior experience, behavioral state at the time of exposure, and indirect effects. Responses may be also be influenced by other non-sound related factors (Ellison et al. 2012b; Goldbogen et al. 2013; Kight and Swaddle 2011; McGregor 2013; Read et al. 2014a; Williams et al. 2014a). McGregor (2013) summarized sound impacts and described two types of possible effects based on the studies they reviewed: (1) an apparent effect of noise on communication, but with a link between demonstrated proximate cost and ultimate cost in survival or reproductive success being inferred rather than demonstrated, and (2) studies showing a decrease in population density or diversity in relation to noise, but with a relationship that is usually a correlation, so factors other than noise or its effect on communication might account for the relationship. Within the ocean environment, aggregate anthropogenic impacts have to be considered in context of natural variation and climate change (Boyd and Hutchins 2012). These contexts can include additive effects from two or more factors, multiplicity where response from two or more factors is greater than the sum of individual effects, synergism between factors and response, antagonism as a negative feedback between factors, acclimation as a short-term individual response, and adaptation as a long-term population change (Boyd and Hutchins 2012). To address aggregate impacts and responses from any changes due to processes such as habituation, tolerance, and sensitization, future experiments over an extended period of time still need further research (Bejder et al. 2009; Blickley et al. 2012; Read et al. 2014b).

Some, including Goldbogen et al. (2013) and Stockin et al. (2008) have speculated that repeated interruptions of a marine mammal's normal activity could lead to fitness consequences and eventually, long-term implications for the population. However, to our knowledge, empirical data has not confirmed this to be the case. For example, Goldbogen et al. (2013) suggested that if a blue whale responded to MFA sonar by temporarily interrupting feeding behavior, this could have impacts on individual fitness and eventually, population health. However, for this to be true, we would have to assume that an individual whale could not compensate for this lost feeding opportunity by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. There is no indication this is the case, particularly since unconsumed prey would still be available in the environment following the cessation of acoustic exposure.

If sound exposure were to be concentrated in a relatively small geographic area over a long period of time, it would be possible for individuals confined to a specific area to be exposed to acoustic stressors (e.g., LFA sonar) multiple times during a relatively short time period. However, we do not expect this to occur as we would expect individuals to move and avoid areas where exposures to acoustic stressors are at higher levels (e.g., greater than 120 dB). For example, Goldbogen et al. (2013) indicated some horizontal displacement of deep foraging blue whales in response to simulated MFA sonar. Given these animal’s mobility and large ranges, we would expect these individuals to temporarily select alternative foraging sites nearby until the exposure levels in their initially selected foraging area have decreased. Therefore, even temporary displacement from initially selected foraging habitat is not expected to impact the fitness of any individual animals because we would expect equivalent foraging habitat to be available in close proximity. Because we do not expect any fitness consequences from any individual animals, we do not expect any population level effects from these behavioral responses.

7.6.1.4 *Exposure Estimates for the Five-Year Proposed Action*

Under the proposed five-year action, the Navy may operate in all non-polar areas of the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea. It is not feasible for the Navy to estimate take of all marine mammal species and stocks for all potential global mission areas for all seasons. For this reason, the Navy selected 26 mission areas (Table 48) representative of the different geographic locations where the Navy may operate SURTASS LFA sonar over the next five years. The locations (latitude/longitude of the center) of the 26 modeled mission areas are described further in the the Navy’s biological evaluation (Navy 2016). In each of these mission areas, the Navy estimated take of marine mammal species for a single 24-hour transmission in that location. Note that these takes estimates do not represent take that is reasonably certain to occur. As described previously, the Navy can only predict the level and general location (i.e., mission areas) of SURTASS LFA sonar operations for a one-year period into the future. Therefore, the exact distribution of the annual missions among the operating areas over the full duration of the five-year period of the MMPA rulemaking are not available for this consultation. However, under mitigation and monitoring measures for the proposed five-year action (described in the Navy’s biological evaluation and the National Defense Exemption), the Navy will conduct missions such that less than 12 percent of any marine mammal stocks would be taken by, Level B harassment (behavior and TTS), as defined under the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels. The Navy will use this annual take limit to guide its mission planning and selection of potential operational mission areas.

The total take estimates during a representative 24-hour mission by Level B harassment (behavior and TTS) by percentage of the marine mammal stock affected for mission areas 1 to 26 are described in section 2.1.7.

Table 48. Mission areas representative of the different geographic locations where the Navy may operate SURTASS LFA sonar over the next five years.

Mission Area Number	Mission Area – Modeled Site
1	East of Japan
2	North Philippine Sea
3	West Philippine Sea
4	Offshore Guam
5	Sea of Japan
6	East China Sea
7	South China Sea
8	Offshore Japan (25 to 40° North)
9	Offshore Japan (10 to 25° North)
10	Hawaii North
11	Hawaii South
12	Offshore Southern California
13	Western North Atlantic (Off Florida)
14	Eastern North Atlantic
15	Mediterranean Sea
16	Arabian Sea
17	Andaman Sea
18	Panama Canal (West Approach)
19	Northeast Australia
20	Northwest Australia
21	Northeast of Japan
22	Gulf of Alaska
23	Norwegian Basin

24	Western North Atlantic (Off Norfolk, Virginia)
25	Labrador Sea
26	Sea of Okhotsk

Sea Turtles

As discussed, the Navy did not use AIM to assess the exposure of sea turtles to SURTASS LFA sonar. Due to a lack of sea turtle density data in the open ocean environment where SURTASS LFA operates, we do not have enough information available to estimate the number of sea turtles that will be exposed to SURTASS LFA sonar and potentially be affected by that exposure. However, juvenile and adult stages of sea turtles could be exposed to SURTASS LFA sonar transmission when residing in pelagic environments. The Navy's HF/M3 system is able to detect some sea turtles within the 180 dB re: 1 µPa mitigation zone (Navy 2012a; Navy 2016; Navy 2017b). We assume that the monitoring protocols associated with SURTASS LFA sonar would be more effective with larger sea turtles, such as adult leatherback and loggerhead sea turtles, than with smaller species such as green, hawksbill, Kemp's ridley, and olive ridley turtles or smaller individual leatherback or loggerhead sea turtles. Monitoring measures may not detect some smaller sea turtles, which would increase their risk of exposure to sound pressure levels associated with SURTASS LFA sonar within the mitigation or buffer zone (that is, 180 dB or 174 dB, respectively) if they encountered SURTASS LFA sonar vessels during sonar transmission. However, due to the small size of the LFA sonar mitigation zone relative to the enormous area and volume of the ocean and water column usage by sea turtles (i.e., indicating a low likelihood of co-occurrence), and the three-part monitoring system, most sea turtles will not be exposed to SURTASS LFA sonar transmission levels greater than or equal to 180 dB re: 1 µPa (rms). For instance, in 2011, a sea turtle was observed by visual observers aboard the USNS *EFFECTIVE* at a distance of about 15 m (49 ft) from the vessel over eight minutes after LFA sonar transmissions ceased. Due to the proximity to the vessel, an assessment was made to determine the potential for the sea turtle to be within the LFA mitigation zone (180 dB sound field) and to determine whether the HF/M3 sonar should have detected the sea turtle. Due to the position of the HF/M3 sonar above the LFA vertical line array, the sea turtle would have had to dive from the surface through the HF/M3 sonar detection zone prior to entering into the 180 dB LFA sonar mitigation zone, making the potential for an acoustic detection of the sea turtle highly likely. The lack of detection by the HF/M3 sonar would indicate that the sea turtle remained at or near the surface and did not dive into the 180 dB LFA sonar mitigation zone during transmissions. Thus, it is improbable that the sea turtle was exposed to SURTASS LFA sonar at or above 180 dB re: 1 µPa (rms). It is more probable that sea turtles could be exposed to SURTASS LFA sonar at levels less than 180 dB re: 1 µPa (rms).

Since under the proposed five-year action, the Navy may operate in all non-polar areas of the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea, any sea turtle species that reside in these areas could be exposed to and affected by SURTASS LFA sonar. This includes all sea turtle species and DPSs considered in this opinion (Table 46).

7.6.1.5 *Annual Exposure Estimates Based on First Year Mission Areas*

For the first year, the Navy proposes a total of 20 nominal LFA sonar missions for four SURTASS LFA sonar vessels in the 15 operational areas listed below. The take, by Level B harassment as defined under the MMPA (TTS and behavioral), for the period from August 2017 through August 2018 is detailed below. The Navy can only predict the level and general location (i.e., mission areas) of SURTASS LFA sonar operations for a one-year period into the future. However, because the locations of Navy SURTASS LFA sonar operations have changed minimally since 2002, this consultation assumed that future take (e.g., for years two through five of the proposed action) by MMPA Level B harassment, will occur in the same mission areas as those anticipated in the first year. While the mission areas are not expected to change, the amount of marine mammal take that is reasonably certain to occur does vary from year to year (though no more than 12 percent of any particular species or stock will be taken by Level B harassment annually). This consultation considered the upper limits of potential takes of marine mammals for the duration of the proposed action and into the reasonably foreseeable future and assumed, based on Navy’s operational history, that the SURTASS LFA sonar mission areas will not change from those proposed in the first year. If the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, such a change would require additional consultation under section 7 of the ESA that tiers off of the programmatic analysis in this consultation.

For the first year, the Navy proposes to operate in the following areas:

- Up to 16 missions in the western North Pacific Ocean, which includes the following operational areas: east of Japan; North Philippine Sea; west Philippine Sea; offshore Guam; Sea of Japan; East China Sea; South China Sea; Japan (25 to 40° North and 10 to 25° North), and northeast of Japan.
- Up to two missions in the central North Pacific Ocean, which includes the northern and southern Hawaii mission areas.
- Up to two missions in the Indian Ocean, which includes the Arabian Sea, Andaman Sea, and northwest of Australia.

Modeling to determine impacts from exposure to LFA sonar transmissions on marine mammals was based on the number of missions (i.e., a nominal seven-day mission) per mission area. Nominal operational assumptions for the model were a mission lasting seven days with an LFA sonar duty cycle of 7.5 percent, which is equal to 12.6 hours of LFA sonar transmission per mission. The tables below present exposures for each species to SURTASS LFA sonar at received levels between 120 and 180 dB sound pressure level during the 2017 through 2018 annual period. Exposures at these levels could result in either TTS or behavioral response.

Blue Whale

For the first year, blue whales may be exposed to and affected by SURTASS LFA sonar during a proposed 17 missions in 12 mission areas from August 2017 through August 2018 (Table 49). For the purposes of this consultation, we assume that there will be take in subsequent years of blue whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 49. Estimated blue whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	WNP	9,250	<0.01	2	69
2	North Philippine Sea	3	WNP	9,250	<0.01	2	93
3	West Philippine Sea	3	WNP	9,250	<0.01	2	101
4	Offshore Guam	3	WNP	9,250	<0.01	2	24
8	Offshore Japan (25 to 40° North)	1	WNP	9,250	<0.01	1	112
9	Offshore Japan (10 to 25° North)	1	WNP	9,250	<0.01	1	65
15	Northeast of Japan	0.5	WNP	9,250	-- --[4]	-- --[4]	196
Total WNP Stock					<0.01	10	660
10	Hawaii North	1	CNP – Hawaii	133	0.86	2	555
11	Hawaii South	1	CNP – Hawaii	133	1.31	2	93
Total CNP – Hawaii Stock					2.17	4	648

12	Arabian Sea	0.5	North Indian	3,442	0.01	1	130
13	Andaman Sea	1	North Indian	3,442	0.01	1	72
Total North Indian Stock					0.02	2	202
14	Northwest of Australia	0.5	South Indian	1,657	0.03	1	157
Total South Indian Stock					0.03	1	157
Totals		17			2.22	17	1,667

WNP=Western North Pacific

CNP=Central North Pacific

[1] Percent of stock or DPS has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

[4] Not expected in the mission area during that season.

False Killer Whale – Main Hawaiian Islands Insular DPS

For the first year, the Main Hawaiian Islands Insular DPS of false killer whales may be exposed to and affected by SURTASS LFA sonar during a proposed two missions in two mission areas from August 2017 through August 2018 (Table 50). For the purposes of this consultation, we assume that there will be take in subsequent years of Main Hawaiian Islands Insular DPS false killer whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 50. Estimated Main Hawaiian Islands Insular DPS of false killer whale exposures to SURTASS LFA sonar received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]

10	Hawaii North (25° North, 158° West)	1	MHI Insular DPS	151	1.02	2	1,175
11	Hawaii South (19.5° North, 158.5° West)	1	MHI Insular DPS	151	2.68	5	594
Total MHI Insular DPS					3.70	7	1,769
Totals		2			3.70	7	1,769

MHI=Main Hawaiian Islands

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Fin Whale

For the first year, fin whales may be exposed and affected by SURTASS LFA sonar during a proposed 20 missions in 15 mission areas from August 2017 through August 2018 (Table 51). For the purposes of this consultation, we assume that there will be take in subsequent years of fin whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 51. Estimated fin whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	WNP	9,250	0.02	2	866

2	North Philippine Sea	3	WNP	9,250	0.08	8	1,215
3	West Philippine Sea	3	WNP	9,250	0.07	7	1,294
4	Offshore Guam	3	WNP	9,250	<0.01	2	24
5	Sea of Japan	1	WNP	9,250	1.17	109	7,571
7	South China Sea	1	WNP	9,250	0.02	2	1,545
8	Offshore Japan (25 to 40° North)	1	WNP	9,250	<0.01	1	716
9	Offshore Japan (10 to 25° North)	1	WNP	9,250	<0.01	1	64
15	Northeast of Japan	0.5	WNP	9,250	1.23	114	4,017
Total WNP Stock					2.59	246	17,312
6	East China Sea	1	ECS	500	1.81	10	672
Total ECS Stock					1.81	10	672
10	Hawaii North (25° North, 158° West)	1	Hawaii	154	0.80	2	657
11	Hawaii South (19.5° North, 158.5° West)	1	Hawaii	154	1.21	2	111
Total Hawaii Stock					2.01	4	786
12	Arabian Sea	0.5	North Indian	1,716	0.43	8	1,257

13	Andaman Sea	1	North Indian	1,716	<0.01	1	21
Total North Indian Stock					0.43	9	1,278
14	Northwest of Australia	0.5	South Indian	38,185	0.04	15	6,389
Total South Indian Stock					0.04	15	6,389
Totals		20			6.88	284	26,437

WNP=Western North Pacific

ECS=East China Sea

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Gray Whale – Western North Pacific Population

For the first year, gray whales from the Western North Pacific population may be exposed to and affected by SURTASS LFA sonar during a proposed 3.5 missions in four mission areas from August 2017 through August 2018 (Table 52). For the purposes of this consultation, we assume that there will be take in subsequent years of gray whales from the Western North Pacific population, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 52. Estimated Western North Pacific Population of Gray Whale exposures to SURTASS LFA at received levels between 120 and 180 dB SPL during 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
5	Sea of Japan	1	WNP	140	0.05	1	99

6	East China Sea	1	WNP	140	0.35	1	26
7	South China Sea	1	WNP	140	0.04	1	75
15	Northeast of Japan	0.5	WNP	140	0.02	1	6
Total WNP Stock					0.46	4	206
Totals		3.5			0.46	4	206

WNP=Western North Pacific

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Humpback Whales

For the first year, humpback whales from the Western North Pacific and Arabian Sea DPSs may be exposed to and affected by SURTASS LFA sonar during a proposed 15 missions in nine mission areas from August 2017 through August 2018 (Table 53). For the purposes of this consultation, we assume that there will be take in subsequent years of humpback whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 53. Estimated humpback whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	WNP	1,059	0.08	1	1,483

2	North Philippine Sea	3	WNP	1,059	4.39	48	7,884
3	West Philippine Sea	3	WNP	1,059	4.69	51	8,736
4	Offshore Guam	3	WNP	1,059	0.67	4	1,588
7	South China Sea	1	WNP	1,059	0.18	2	2,628
8	Offshore Japan (25 to 40° North)	1	WNP	1,059	0.06	1	2,197
9	Offshore Japan (10 to 25° North)	1	WNP	1,059	1.36	15	2,171
15	Northeast of Japan	0.5	WNP	1,059	2.53	27	9,769
Total WNP Stock					13.96	149	36,456
12	Arabian Sea	0.5	Arabian Sea	82	0.33	1	134
Total Arabian Sea DPS					0.33	1	134
Totals		14.5			14.29	150	36,590

WNP=Western North Pacific

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

North Pacific Right Whale

For the first year, North Pacific right whales may be exposed to and affected by SURTASS LFA sonar during a proposed eight missions in six mission areas from August 2017 through August 2018 (Table 54). For the purposes of this consultation, we assume that there will be take in subsequent years of North Pacific right whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 54. Estimated North Pacific right whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	WNP	922	<0.01	1	47
2	North Philippine Sea	3	WNP	922	0.03	1	59
5	Sea of Japan	1	WNP	922	-- --[4]	-- --[4]	54
6	East China Sea	1	WNP	922	0.06	1	16
7	South China Sea	1	WNP	922	0.04	1	52
15	Northeast of Japan	0.5	WNP	922	1.13	11	132
Total WNP Stock					1.26	15	360
Totals		8			1.26	15	360

WNP=Western North Pacific

[1] Percent of stock or DPS has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

[4] Not expected in the mission area during that season.

Sei Whale

For the first year, sei whales may be exposed to and affected by SURTASS LFA sonar during a proposed 9.5 missions in eight mission areas from August 2017 through August 2018 (Table 55). For the purposes of this consultation, we assume that there will be take in subsequent years of sei whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 55. Estimated sei whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	NP	7,000	0.15	12	6,111
4	Offshore Guam	3	NP	7,000	0.06	4	834
8	Offshore Japan (25 to 40° North)	1	NP	7,000	0.05	4	3,100
9	Offshore Japan (10 to 25° North)	1	NP	7,000	1.63	115	18,329
15	Northeast of Japan	0.5	NP	7,000	4.45	312	3,868
Total NP Stock					6.34	447	32,242
10	Hawaii North (25° North, 158° West)	1	Hawaii	391	0.78	4	1,726
11	Hawaii South (19.5° North 158.5° West)	1	Hawaii	391	1.22	5	293
Total Hawaii Stock					2.00	9	2,019

14	Northwest of Australia	0.5	Indian	13,854	<0.01	1	76
Total Indian Stock					<0.01	1	76
Totals		9.5			8.34	457	34,337

NP=North Pacific

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Sperm Whale

For the first year, sperm whales may be exposed to and affected by SURTASS LFA sonar during a proposed 20 nominal missions in 15 mission areas from August 2017 through August 2018 (Table 56). For the purposes of this consultation, we assume that there will be take in subsequent years of sperm whales, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 56. Estimated sperm whale exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
1	East of Japan	1.5	NP	102,112	0.03	32	14,320
2	North Philippine Sea	3	NP	102,112	0.06	73	14,621
3	West Philippine Sea	3	NP	102,112	0.06	65	15,582

4	Offshore Guam	3	NP	102,112	0.06	53	5,174
5	Sea of Japan	1	NP	102,112	0.06	66	12,001
6	East China Sea	1	NP	102,112	0.02	22	3,038
7	South China Sea	1	NP	102,112	0.02	16	11,900
8	Offshore Japan (25 to 40° North)	1	NP	102,112	0.03	36	33,155
9	Offshore Japan (10 to 25° North)	1	NP	102,112	0.03	34	27,994
15	Northeast of Japan	0.5	NP	102,112	0.07	73	47,759
Total NP Stock					0.44	470	185,544
10	Hawaii North (25° North, 158° West)	1	Hawaii	4,559	0.57	27	22,848
11	Hawaii South (19.5° North 158.5° West)	1	Hawaii	4,559	0.39	18	3,108
Total Hawaii Stock					0.96	45	25,956
12	Arabian Sea	0.5	North Indian	24,446	0.29	73	34,288
13	Andaman Sea	1	North Indian	24,446	0.04	11	2,901
Total North Indian Stock					0.33	84	37,189
14	Northwest of Australia	0.5	South Indian	24,446	0.03	9	6,779
Total South Indian Stock					0.03	9	6,779

Totals	20		1.76	608	255,468

NP=North Pacific

[1] Percent of stock or DPS has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Hawaiian Monk Seal

For the first year, Hawaiian monk seals may be exposed to and affected by SURTASS LFA sonar during a proposed three missions in three mission areas from August 2017 through August 2018 (Table 57). For the purposes of this consultation, we assume that there will be take in subsequent years of Hawaiian monk seals, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy’s biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 57. Estimated Hawaiian monk seal exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
8	Offshore Japan (25 to 40° North)	1	Hawaii	1,400	0.12	2	1,240
10	Hawaii North (25° North, 158° West)	1	Hawaii	1,400	0.95	14	10,644
11	Hawaii South (19.5° North	1	Hawaii	1,400	0.05	1	80

	158.5° West)						
Total Hawaii Stock					1.12	17	11,964
Totals		3			1.12	17	11,964

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Spotted Seal – Southern DPS

For the first year, spotted seals from the Southern DPS may be exposed to and affected by SURTASS LFA sonar during a proposed two missions in two mission areas from August 2017 through August 2018 (Table 58). For the purposes of this consultation, we assume that there will be take in subsequent years of Southern DPS spotted seals, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 58. Estimated Southern DPS of spotted seal exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
5	Sea of Japan	1	Southern DPS	3,500	<0.01	1	47
6	East China Sea	1	Southern DPS	1,000	0.02	1	34
Total Southern DPS					0.02	2	81
Totals		2			0.02	2	81

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how

many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Steller Sea Lion – Western DPS

For the first year, Steller sea lions from the Western DPS may be exposed to and affected by SURTASS LFA sonar during a proposed 0.5 mission in one mission area from August 2017 through August 2018 (Table 59). For the purposes of this consultation, we assume that there will be take in subsequent years of Western DPS Steller sea lions, by Level B harassment, in these same mission areas at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and as described in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels).

Table 59. Estimated Western DPS of Steller sea lion exposures to SURTASS LFA sonar at received levels between 120 and 180 dB SPL during the 2017 through 2018 annual period.

Mission Area Number	Operating Area	Number of Missions	Stock or DPS	Number in Stock or DPS	Percent Stock Affected 120 to 180 dB[1]	Estimated Number of Instances of Level B Harassment[2]	Estimated Exposures without Criteria Processing[3]
15	Northeast of Japan	0.5	Western	69,704	<0.01	2	256
Total Western					<0.01	2	256
Totals		0.5			<0.01	2	256

[1] Percent of DPS or stock has been rounded up to two decimal points.

[2] This column represents the estimated number of animals that will exhibit a behavioral response (i.e., be affected) by exposure to SURTASS LFA sonar between 120 and 180 dB SPL during the annual period. The SURTASS LFA sonar risk continuum, as described in section 3.8.14, was used to determine how many exposures between 120 and 180 dB SPL would be expected to result in a behavioral response.

[3] This column represents the estimated number of exposures that will occur between 120 and 180 dB SPL (rms) during the 2017 through 2018 annual period. Fractional animals potentially affected have been rounded up to the next whole number.

Sea Turtles

Only sea turtle species that occur in the 15 operational areas listed in Table 60 are expected to be exposed to SURTASS LFA sonar during the 2017 through 2018 annual period. The Navy can only predict the level and general location (i.e., mission areas) of SURTASS LFA sonar operations for a one-year period into the future. However, these levels and locations have changed minimally since 2002. Based on the Navy's operational history, this consultation assumes that the Navy's SURTASS LFA sonar operations will continue to be used in these same mission areas for the duration of the five-year proposed action and into the reasonably foreseeable future. Therefore, we expect that the sea turtle species that occur in the 15 operational areas listed in Table 60 are expected to be exposed to SURTASS LFA sonar in future years as well.

As described previously, we do not have information available that would allow us to estimate the number of sea turtles of each species exposed to, and potentially affected by, SURTASS LFA sonar. However, because a sea turtle would need to remain within 44 m (143 ft) of the LFA sonar for an entire 60-seconds signal without being detected to experience auditory effects (see section 7.4.2 for additional detail), the small size of the LFA sonar mitigation zone relative to the enormous area and volume of the ocean and water column usage by sea turtles (i.e., indicating a low likelihood of co-occurrence), and the three-part monitoring system which is expected to detect some sea turtles (Navy 2012a; Navy 2016; Navy 2017b), particularly individuals in close proximity, the sea turtle species/DPSs listed below are unlikely to be exposed to SURTASS LFA sonar transmission levels that could cause PTS or TTS.

Individual sea turtles in the mission areas listed below are expected to experience behavioral harassment due to exposure to SURTASS LFA sonar. As explained in Section 3.1.2, due to the lack of more definitive data on sea turtle abundance or density in the open ocean, it is not feasible to estimate the percentage of each sea turtle species or DPS (or number of individuals) that could be located in a SURTASS LFA sonar operations area at a potentially vulnerable depth during an LFA sonar sound transmission. For this reason and in accordance with 80 FR 26832, we will use a habitat surrogate approach to express the extent of anticipated incidental take of ESA-listed sea turtles from the operation of SURTASS LFA sonar. Due to the mitigation and monitoring procedures that will be implemented by the Navy, we expect most sea turtles (particularly larger individuals) will be detected if they were to occur within the 180 dB mitigation zone. However, detection rates are not expected to be 100 percent due to the small size of some sea turtles. Any turtles exposed to sound pressure levels at 175 dB or greater would be expected to exhibit erratic behavior indicating the animal was in an agitated state (McCauley et al. (2000)). The extent of take is the area of the water column exposed to sound pressure levels from the source to 175 dB during SURTASS LFA sonar operations in the form of harassment.

Table 60. Sea turtle species likely to occur in each mission area.

Mission Area Number	Mission Area – Modeled Site	Sea Turtle Species/DPSs Present
1	East of Japan	Green Turtle – Central West Pacific, East Indian-West Pacific DPSs; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS

2	North Philippine Sea	Green Turtle – Central West Pacific, East Indian-West Pacific DPSs; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
3	West Philippine Sea	Green Turtle – East Indian-West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
4	Offshore Guam	Green Turtle – Central West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
5	Sea of Japan	Green Turtle – East Indian-West Pacific DPS; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
6	East China Sea	Green Turtle – East Indian-West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
7	South China Sea	Green Turtle – East Indian-West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
8	Offshore Japan (25 to 40° North)	Green Turtle – Central West Pacific DPS; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
9	Offshore Japan (10 to 25° North)	Green Turtle – Central West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
10	Hawaii North	Green Turtle – Central North Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
11	Hawaii South	Green Turtle – Central North Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Pacific Ocean DPS
12	Arabian Sea	Green Turtle – North Indian DPS; Hawksbill Turtle; Loggerhead Turtle – North Indian Ocean DPS
13	Andaman Sea	Green Turtle – East Indian-West Pacific DPS; Hawksbill Turtle; Leatherback Turtle; Loggerhead Turtle – North Indian Ocean DPS
14	Northwest of Australia	Green Turtle – East Indian-West Pacific DPS; Hawksbill Turtle; Loggerhead Turtle – Southeast Indo-Pacific Ocean DPS
15	Northeast of Japan	Loggerhead Turtle – North Pacific Ocean DPS

7.6.2 Response Analysis

The Risk Assessment Framework for SURTASS LFA sonar (Sections 7.3 and 7.4) discussed the potential responses of mysticetes, odontocetes, pinnipeds, and sea turtles to exposure to SURTASS LFA sonar. Based on the literature presented in these sections and the exposure estimates presented in Section 7.6.1, this section details our conclusions on the response of mysticetes, odontocetes, pinnipeds, and sea turtles to exposure to this stressor. The response analysis presented below is applicable to exposures that could occur for the duration of the five-year proposed action.

7.6.2.1 *Mysticetes*

As discussed previously, based on the performance of the SURTASS LFA sonar system and the mitigation measures the Navy has used with the SURTASS LFA sonar system over the past 15 years (2002 through 2017), it is unlikely that any baleen whales (blue, Bryde's, fin, gray, humpback, North Atlantic right, North Pacific right, Southern right, or sei whales) would be exposed to received levels equal to or greater than 180 dB (or even 174 dB considering the buffer zone that will be implemented). The available evidence (presented in section 7.3) suggests that at received levels below 180 dB SPL, exposure to LFA sonar transmissions is not likely to result in injury, significant masking, stranding, resonance effects, or other long-term behavioral effects in marine mammals. The best scientific and commercial data available (presented in Section 7.3) suggest that mysticetes exposed to SURTASS LFA sonar may react behaviorally or experience TTS. However, many mysticetes exposed may not experience TTS or respond at all. Since SURTASS LFA sonar operates at a frequency between 100 and 500 Hz, mysticetes are expected to be able to hear SURTASS LFA sonar if exposed (NOAA 2016b). Below we discuss the likely responses of mysticetes to exposures that could result in TTS or behavioral response and the potential for these exposures to result in fitness consequences to individual animals.

Section 7.3.3 presented a detailed discussion on the potential behavioral responses of marine mammals following exposure to low-frequency active sonar. For example, as part of determining the potential effects of SURTASS LFA sonar, the Navy conducted the LFS SRP, which exposed baleen whales to received levels ranged from 120 to 155 dB. In response to LFA sonar, blue and fin whales did not exhibit any overt behavioral responses or changes in distribution, whereas gray whales avoided the sound source following exposure and humpback whales lengthened their songs in response to low frequency broadcasts. All responses to the sound source were short-term (Clark and Fristrup 2001b; Croll et al. 2001; Fristrup et al. 2003; Miller et al. 2000a; Nowacek et al. 2007). When an LFA sonar signal (source levels of 170 and 178 dB re: 1 µPa [rms] sound pressure level) was placed in the center of gray whale migration corridor, the animals made minor course changes and resumed their normal activities within tens of minutes after the initial exposure to the LFA sonar signal (Clark and Fristrup 2001b). When the source was moved offshore to the edge of the migratory corridor, with an increased source level to maintain the same received levels at the whales, the migrating animals exhibited no response to the sonar (Clark et al. 1999). Miller et al. (2000b) and Fristup et al. (2003) found that humpback whales might lengthen their songs in response to low frequency broadcasts, but this response was relatively brief in duration, with the animals resuming normal behaviors within a couple hours of the last LFA sonar source transmission. These temporary responses 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. For example, Fristup et al. (2003) stated in regards to the response of humpback whales to low-frequency sound broadcasts that "dramatic changes in humpback singing behavior would have demographic consequences, but the effects documented here do not seem to pose this risk." Further, as noted in (Southall et al. 2007), 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. This is not expected to occur as a result of SURTASS LFA sonar. This conclusion 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 (stock or DPS) level effects from these behavioral responses.

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 in the vicinity of the sound source for an extended period of time. We would not expect this to be the case due to the mitigation and monitoring measures implemented by the Navy, the low duty cycle of SURTASS LFA sonar, and that both the animal and vessel would be moving (most likely not in the same direction). Additionally, though the frequency range of TTS that mysticetes are likely to sustain would overlap with some of the frequency ranges of their vocalization types, the frequency range of TTS from SURTASS LFA sonar would not usually span the entire frequency range of one vocalization type, much less span all types of vocalizations or other critical auditory cues. Given the brief amount of time mysticetes are expected to experience TTS and the limited frequency range in which this TTS is expected to occur, it is unlikely to significantly impair their ability to communicate, forage, or breed and will not have fitness level consequences at the individual level. Because we do not expect any fitness consequences from any individual animals to result from instances of TTS, we do not expect any population (stock or DPS) level effects from instances of TTS.

As described further in section 7.3.7, establishing a causal link between anthropogenic noise, animal communication, and individual impacts as well as population viability is difficult to quantify and assess (McGregor 2013; Read et al. 2014a; Southall et al. 2016). To date, “we do not yet have the data to underpin the link between behavioral response and population consequences” (Harris et al. 2017). It is difficult to assess the effects of sounds individually and cumulatively on marine species because a number of factors can influence these effects including: indirect effects, age class, prior experience, behavioral state at the time of exposure, and that responses may be influenced by other non-sound related factors (DeRuiter et al. 2017;

Ellison et al. 2012a; Friedlaender et al. 2016; Goldbogen et al. 2013; Harris et al. 2017; Kight and Swaddle 2011; McGregor 2013; Read et al. 2014b; Williams et al. 2014b). However, although there is significant uncertainty, based upon the available evidence and the foregoing analysis, we conclude that modeled instances of behavioral disturbance and TTS are unlikely to cause aggregate or long-term adverse effects on the baleen whales considered in this consultation, such as abandonment of important habitat or adverse physiological effects resulting from chronic or long-term stress.

7.6.2.2 *Odontocetes*

As discussed previously, based on the performance of the SURTASS LFA sonar system and the mitigation measures the Navy has used with the sonar system over more than 15 years of its use (2002 through 2017), it is unlikely that any odontocetes (e.g., sperm and Main Hawaiian Islands Insular DPS of false killer whales) would be exposed to received levels equal to or greater than 180 dB SPL (or even 174 dB considering the buffer zone that will be implemented). The available evidence suggests that at received levels below 180 dB, exposure to SURTASS LFA sonar transmissions is not likely to result in injury, TTS, significant masking, stranding, resonance effects, or other long-term behavioral effects in odontocetes. Though data are limited that consider the behavioral response of odontocetes to low-frequency sources, the best scientific and commercial data available (presented in sections 7.3) suggest that exposing individual odontocetes to SURTASS LFA sonar may cause those animals to react behaviorally, but many animals exposed at these received levels may not respond at all. Below we discuss the likely responses of odontocetes to exposures that could result in behavioral response and the potential for these exposures to result in fitness consequences to individual animals.

It’s worth noting here that SURTASS LFA sonar operates at a frequency between 100 and 500 Hz, which is at the lower end of odontocete’s hearing range (150 Hz to 160 kHz; NOAA 2016b). Aicken et al. (2005) monitored the behavioral responses of sperm whales to an LFA sonar system that was being developed for use by the British Navy and found no evidence of behavioral responses that could be attributed to the LFA sonar. On the other hand and as described further in section 7.3, Antunes et al. (2014) and Miller et al. (2014) did observe avoidance responses from odontocetes at received levels ranging from 142±15 dB re: 1 µPa to approximately 170 dB re: 1 µPa or 173 dB SEL_{cum}. In the Antunes et al. (2014) study, the responses did not last longer than the duration of the sonar exposure and the animals returned to previous movement patterns once the sonar ceased transmitting. Isojunno et al. (2016) found that sperm whales reduced foraging effort during exposure to 1 to 2 kHz sonar (a higher frequency than SURTASS LFA sonar), but that the animals transitioned back to foraging within approximately eight minutes following cessation of the exposure.

Further, to preserve the saliency of their vocalizations and the coherence of their social interactions, odontocetes might have to make one or more vocal adjustments. Because any reductions in the active space of whale vocalizations that result from SURTASS LFA sonar would be temporary and episodic, any vocal adjustments odontocetes would have to make would also be temporary. Studies on a captive false killer whale have demonstrated an ability to proactively change hearing sensitivity, apparently for protection, when a warning sound was provided prior to a more intense sound and that the animal learned to change its hearing sensitivity when warned that a loud sound was about to arrive (Nachtigall and Supin 2013). Controlled exposure experiments in the Bahamas found that after each MFA reception of simulated MFA sonar sounds (3.1 to 3.4 kHz, source level 160 to 211 dB re: 1 µPa) false killer whales increased their whistle rate and produced whistles that were more similar in their frequency characteristics to MFA sonar (Goldbogen et al. 2013). If necessary, we would expect odontocetes to be able to similarly alter their communication in response to LFA sonar.

Similar to the behavioral reactions of mysticetes, potential behavioral responses of odontocetes to SURTASS LFA sonar 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. 2007), 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 (e.g., Antunes et al. 2014; Isojunno et al. 2016) 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 (stock or DPS) level effects from these behavioral responses.

Establishing a causal link between anthropogenic noise, animal communication, and individual impacts as well as population viability is difficult to quantify and assess (McGregor 2013; Read et al. 2014a; Southall et al. 2016). To date, "we do not yet have the data to underpin the link between behavioral response and population consequences" (Harris et al. 2017). It is difficult to assess the effects of sounds individually and cumulatively on marine species because a number of factors can influence these effects including: indirect effects, age class, prior experience, behavioral state at the time of exposure, and that responses may be influenced by other non-sound related factors (DeRuiter et al. 2017; Ellison et al. 2012a; Friedlaender et al. 2016; Goldbogen et al. 2013; Harris et al. 2017; Kight and Swaddle 2011; McGregor 2013; Read et al. 2014b; Williams et al. 2014b). For example, as discussed previously, New et al. (2013) developed a mathematical model simulating a functional link between feeding energetics and a species' requirements for survival and reproductions for 21 species of beaked whale (not ESA-listed, but also odontocetes). However, while the New et al. (2013) model provides a test case for future research, this pilot study has very little of the critical data necessary to form any conclusions applicable to current management decisions. The authors note the need for more data on prey species and reproductive parameters including gestation and lactation duration, as the model results are particularly affected by these assumptions. Therefore, any suggestion of biological sensitivity to the simulation's input parameters is uncertain.

Although there is uncertainty, based upon the available evidence and the foregoing analysis, we conclude that modeled instances of behavioral disturbance is unlikely to cause aggregate or long-term adverse effects on the odontocetes considered in this opinion, such as abandonment of important habitat or adverse physiological effects resulting from chronic or long-term stress.

7.6.2.3 *Pinnipeds*

As discussed previously, based on the performance of the SURTASS LFA sonar system and the mitigation measures the Navy has used with the LFA sonar system over more than 15 years (2002 through 2017) of sonar deployment, it is unlikely that any ESA-listed pinnipeds (Okhotsk DPS of bearded seals, Guadalupe fur seals, Hawaiian monk seals, Mediterranean monk seals, Arctic DPS and Okhotsk DPS of ringed seals, Southern DPS of spotted seals, or Western DPS of Steller sea lions) would be exposed to received levels equal to or greater than 180 dB SPL (or even 174 dB considering the buffer zone that will be implemented). The available evidence suggests that at received levels below 180 dB, exposure to LFA sonar transmissions are not likely to result in injury (including PTS), masking, stranding, resonance effects, or other long-term behavioral effects in pinnipeds. The best scientific and commercial data available (presented in section 7.3) suggest that exposing individual pinnipeds to SURTASS LFA sonar may cause those animals to react behaviorally or experience TTS. Below we discuss the likely responses of pinnipeds to exposures that could result in TTS or behavioral response and the potential for these exposures to result in fitness consequences to individual animals.

Limited information is available on the effect of low-frequency sonar on pinnipeds. For this reason, we rely largely on data from non-listed pinniped species and other marine mammals (i.e., cetaceans) in our assessment of the likely responses of ESA-listed pinnipeds to SURTASS LFA sonar. We also rely on information regarding how pinnipeds respond to other sources of anthropogenic noise. Pinnipeds can hear in the frequency range from 50 Hz up to 86 kHz (NOAA 2016b). Since SURTASS LFA sonar operates at a frequency between 100 and 500 Hz, we would expect pinnipeds to detect SURTASS LFA sonar if exposed.

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 µPa. 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 SURTASS LFA sonar 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. 2007), 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 (species, stock, or DPS) level effects from these behavioral responses.

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 in the vicinity of the sound source for an extended period of time. We would not expect this to be the case due to the mitigation and monitoring measures implemented by the Navy, the low duty cycle of SURTASS LFA sonar, and that both the animal and vessel would be moving (most likely not in the same direction). Additionally, since SURTASS LFA sonar operates only from 100 to 500 Hz, the frequency range of TTS that pinnipeds are likely to sustain would span only a limited portion of their hearing range. Finally, as stated above, Navy monitoring of Navy-wide activities since 2006 has documented hundreds of thousands of marine mammals on the 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. Given the brief amount of time pinnipeds are expected to experience TTS and the limited frequency range in which TTS could be expected, it is unlikely to significantly impair their ability to communicate, forage, or breed and will not have fitness level consequences at the individual level. Because we do not expect any fitness consequences from any individual animals to result from instances of TTS, we do not expect any population (stock or DPS) level effects from instances of TTS.

Establishing a causal link between anthropogenic noise, animal communication, and individual impacts as well as population viability is difficult to quantify and assess (McGregor 2013; Read et al. 2014a; Southall et al. 2016). To date, “we do not yet have the data to underpin the link between behavioral response and population consequences” (Harris et al. 2017). It is difficult to assess the effects of sounds individually and cumulatively on marine species because a number of factors can influence these effects including: indirect effects, age class, prior experience, behavioral state at the time of exposure, and that responses may be influenced by other non-sound related factors (DeRuiter et al. 2017; Ellison et al. 2012a; Friedlaender et al. 2016; Goldbogen et al. 2013; Harris et al. 2017; Kight and Swaddle 2011; McGregor 2013; Read et al. 2014b; Williams et al. 2014b). New et al. (2014) used a simulation model to assess how behavioral disruptions (e.g., significant disruption of foraging behavior) may affect Southern elephant seal health, offspring survival, individual fitness, and population growth rate. They suggested their model could determine the population consequences of disturbance from short-term changes in individual animals. Their model assumed that disturbance affected behavior by reducing the number of drift dives in which the animals were feeding and increasing the time they spent in transit. For example, they suggested a disturbance lasting 50 percent of an average annual foraging trip would reduce pup survival by 0.4 percent. If this level of disturbance continued over 30 years and the population did not adapt, the authors found that the population size would decrease by approximately ten percent. However, the findings of New et al. (2014) are not applicable to the temporary behavioral disruptions that may be caused by SURTASS LFA sonar for a number of reasons. First, the model assumed that individuals would be unable to compensate for lost foraging opportunities. As described previously, available empirical data does not confirm this would be the case. For example, 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 ESA-listed species 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 SURTASS LFA sonar 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 at a later time. Additionally the behavioral disruption of ESA-listed species reasonably expected to occur due to SURTASS LFA sonar will not have as long of a duration as those considered in the New et al. (2014) study. No individual animals will be exposed to SURTASS LFA sonar for a long enough duration to disrupt 50 percent of its annual feeding opportunities over multiple years. New et al. (2014) suggest it would be unlikely even for episodic environmental change, such as El Niño events, to affect the probability of population persistence. As suggested by the authors, the New et al. (2014) model may be more applicable to the consideration of potential long-term behavioral disruptions (e.g., those that may result from climate change).

Although there is significant uncertainty, based upon the available evidence and the foregoing analysis, we conclude that instances of behavioral disturbance are unlikely to cause aggregate or long-term adverse effects on the pinnipeds considered in this opinion, such as abandonment of important habitat or adverse physiological effects resulting from chronic or long-term stress.

Sea Turtles

Little is known about how sea turtles (green, hawksbill, Kemp’s ridley, olive ridley, leatherback, and loggerhead) use sound in their environment. Based on knowledge of their sensory biology (Bartol and Ketten 2006; Moein Bartol and Musick 2003), sea turtles may be able to detect objects within the water column (e.g., vessels, prey, predators) via some combination of auditory and visual cues. However, while sea turtles may rely on acoustic cues to identify nesting beaches, they appear to rely on other non-acoustic cues for navigation, such as magnetic fields (Lohmann and Lohmann 1996a; Lohmann and Lohmann 1996b) and light (Avens and Lohmann 2003). Additionally, they are not known to produce sounds underwater for communication.

Although the information on the hearing capabilities of sea turtles is limited, the information available suggests that the auditory capabilities of sea turtles are centered in the low-frequency range (less than 2 kHz) (Bartol et al. 1999a; Dow Piniak et al. 2012; Lenhardt et al. 1983; Lenhardt et al. 1994; Martin et al. 2012; O'Hara and Wilcox 1990; Ridgway et al. 1969), with greatest sensitivity below one kHz. A more recent review on sea turtle hearing and sound exposure indicated that sea turtles detect sounds at less than 1,000 Hz (Popper et al. 2014b).

No data are available indicating the potential response of sea turtles to sonar (Popper et al. 2014b). McCauley et al. (2000) studies the response of green and loggerhead sea turtles to airgun arrays at two km and at one km with received levels of 166 and 175 dB re: 1 µPa, respectively. They reported that the sea turtles responded consistently above received levels of about 166 dB re: 1 µPa by increasing their swimming activity compared to period during which the airgun was not operating. Above 175 dB re: 1 µPa their behavior became erratic and might have indicated an agitated state.

O'Hara and Wilcox (1990) exposed loggerhead turtles to low-frequency sound from two types of seismic airguns with source levels approximating 256 and 262 dB re: 1 µPa (the paper does not state whether this was peak, peak-to-peak, or rms). With airguns firing at a rate of four times per minute and source levels of 256 dB, the distribution of loggerhead turtles was not significantly different than during control trials. When they increased the source levels to about 262 dB, the sea turtles avoided the seismic airgun when it fired at four or eight times per minute. Although the sound source in this experiment is not directly comparable to the LFA sonar associated with the proposed operations of the SURTASS LFA sonar system, the results of this study illustrate the relative insensitivity of sea turtles (at least loggerhead turtles) to low-frequency sound.

In their *Sound Exposure Guidelines for Sea Turtles and Fishes*, a technical report developed and approved by Accredited Standards Committee S3/SC 1 Animal Bioacoustics, Popper et al. (2014b) concluded that the risk of sea turtles experiencing immediate morality, serious injury that could lead to death, or recoverable injury was low from exposure to low-frequency sonar. Further, if the animal was located far from the sound source, there was a low risk it could experience TTS, and a moderate risk if the animal was located intermediate or close distances to the source. Due to the monitoring and mitigation measures implemented during SURTASS LFA sonar transmissions that would reduce the likelihood of sea turtles being in close proximity to the sound source, and because a sea turtle would need to remain within 44 m (143 ft) of the LFA sonar for an entire 60-seconds signal without being detected to experience auditory effects (see section 7.4.2 for additional detail), any exposure of sea turtles to LFA sonar signals is not expected to result in morality, injury, or TTS.

Popper et al. (2014b) also determined that the relative risk of sea turtles responding behaviorally to low-frequency sonar is low, regardless of the distance from the source (for additional discussion on potential behavioral reactions of sea turtles to SURTASS LFA sonar, see section 7.4.5). Based on the limited evidence available, sea turtles exposed to LFA sonar may hear the sound. At levels below 175 dB re: 1 µPa, they may not react at all or they may increase their swimming speed and we do not expect such reactions to rise to the level of take under the ESA. Sea turtles exposed to sound pressure levels at or above 175 dB during SURTASS LFA sonar operations could exhibit a behavioral response that would rise to the level of take under the ESA. The response of a sea turtle to an anthropogenic sound such as SURTASS LFA sonar will depend on the duration, as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source and whether it is perceived as approaching or moving away could also affect the way a sea turtle responds. Potential behavioral responses to SURTASS LFA sonar could include startle reactions, disruption of feeding, disruption of migration, changes in respiration, alteration of swim speed, alteration of swim direction, and area avoidance. Any disruptions are expected to be temporary in nature, with the animal resuming normal behaviors shortly after the exposure (if the exposed animal even responds at all). To result in significant fitness consequences we would have to assume that an individual turtle detects and responds to the acoustic source, and that it could not compensate for the energy expended during evasion and any potential lost feeding opportunities by either immediately feeding at another location, by feeding shortly after cessation of acoustic exposure, or by feeding at a later time. Similarly, to result in significant fitness consequences we would have to assume that an individual turtle detects and responds to the acoustic source, and that it could not compensate for the energy expended during evasion. There is no indication this is the case, particularly since foraging habitat would still be available in the environment following the cessation of acoustic exposure. For these reasons, we do not expect sea turtles would exhibit behavioral responses that could impact an individual's fitness if they are exposed to SURTASS LFA sonar.

7.6.3 Repeated Exposure and Potential for Long-Term or Additive Impacts

To address a Court ruling that we take a long-term view of the "action" (*Natural Resources Defense Council et al. v. Pritzker et al.*, 62 F.Supp.3d 969; United States District Court, N.D. California, 2014), we assumed for purposes of this opinion that the Navy's SURTASS LFA sonar routine training, testing, and military operations and associated impacts will continue into the reasonably foreseeable future at levels similar to those assessed in this opinion. This assumption raises the question of whether the Navy's SURTASS LFA sonar operations are reasonably certain to cause any aggregate or long-term impacts over time, beyond the effects of individual takes that could occur in a given year. Further information is provided below.

To address the likelihood of long-term additive or accumulative impacts, we first considered (1) stressors that accumulate in the environment, and (2) effects that represent either the response of individuals, populations, or species to that accumulation of stressors.

Regarding stressors that accumulate in the environment, which captures the normal usage of "cumulative impacts," we concluded that phenomena like sound and ship strike do not accumulate in the environment (sound energy rapidly transforms into other forms of energy and ship strikes are independent events), although phenomena like the acreage of habitat destroyed and concentrations of toxic chemicals, sediment, and other pollutants accumulate[6].

For effects representing the individual, population, or species' response to the accumulation of stressors, we considered phenomena that accumulate in individuals and individually contribute or collectively determine the probable fitness of the individuals that comprise a population. These include, the passage or loss of time (specifically, the loss of time to reproduce, to forage, and to migrate, etc.); reproductive success; longevity; energy debt, including allostatic loading; body burdens of toxic chemicals; the fitness costs of behavioral decisions; injuries and tissue damage;

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[6] Note that we discuss these phenomena to illustrate the types of impacts that accumulate in the environment. Navy SURTASS LFA sonar will not cause these impacts.

and overstimulation of sensory organs (which would include noise-induced losses of hearing sensitivity).

At the level of populations, phenomena that "accumulate" include population abundance; the number of percent of individuals in a population with lifetime reproductive success greater than 2.0; the number of percent of individuals in a population with lifetime reproductive success equal to 2.0; the number or percent of individuals in a population with lifetime reproductive success less than 2.0; the number or percent of individuals that immigrate or emigrate from a population per unit time; mortality within a particular age or stage over generation time; and the reservoir of juveniles in a population that have a high probability of surviving to the age of reproduction (population momentum or its absence). At the species level, when feasible, we accumulate those phenomena that allow us to estimate the extinction risks facing a species. These include increases or decreases in the number of occurrences or populations; the extinction probability of particular occurrences; variance in the rates of population growth or decline; and demographic stochasticity.

We concluded that the effects of repeated exposures to SURTASS LFA sonar were not likely to accumulate through altered energy budgets caused by avoidance behavior (which could reduce the amount of time available to forage), physiological stress responses (mobilizing glucocorticosteroids, which increases an animal's energy demand), or the canonical costs of changing behavioral states (small decrements in the current and expected reproductive success of individuals exposed to the stressors). In particular, we concluded that the species would be exposed on foraging areas and would experience trivial increases in feeding duration, effectiveness, or both, that would not accumulate in a manner that is likely to result in avoidance behavior or altered energy budgets. In short, the impacts expected from sonar exposure are behavioral in nature, temporary and comparatively short in duration, relatively infrequent, and not of the type or severity that would be expected to be additive for the small portion of the stocks and species likely to be exposed either annually, or in the reasonably foreseeable future.

Under certain conditions, chronic exposure to acoustic sources or other stimuli that can cause individual stress or behavioral responses can also lead to additional long-term adverse impacts. For example, investigators concluded that gray whales and humpback whales abandoned some of their coastal habitat in California and Hawaii, respectively, because of persistent underwater noise associated with extensive vessel traffic (Gard 1974; Reeves 1977; Salden 1988). However, the Navy's routine training, testing, and military operations involving SURTASS LFA sonar are infrequent and short-term. Even though an animal's exposure to LFA sonar may be more than one time, the intermittent nature of the sonar signal, its low duty cycle, and the fact that both the vessel and animal are moving provide a very small chance that exposure to active sonar for individual animals and stocks would be repeated or that exposures would occur over extended periods of time. Consequently, the Navy's SURTASS LFA sonar routine training, testing, and military operations do not create conditions of chronic, continuous underwater noise, and will not lead to habitat abandonment or long-term hormonal or physiological stress responses in marine mammals.

As documented above, impacts from sonar exposure are expected to be behavioral in nature, temporary and comparatively short in duration, relatively infrequent, and not of the type or severity that would be expected to be additive for the small portion of the DPSs, stocks, and species likely to be exposed annually, into the reasonably foreseeable future. Thus, while the number of individuals “taken” by LFA sonar increases over time, the effect of each “take” on the survival or reproductive success of the animals themselves would not accumulate in the same way. As a result, for example, we do not expect that exposing one whale to LFA sonar per year at a level that we would consider a take in the form of behavioral harassment or TTS, as predicted by the Navy’s modeling described above, would result in effects over the long-term that would be greater than what we would expect from a single exposure event. To the contrary, we do not expect the effects of that “take” to have any additive, interactive, or synergistic effect on the individual animals, the population(s) those individuals represent, or the species those population(s) comprise.

The preliminary findings from Melcon et al. (2012) and Goldbogen et al. (2013), are also consistent with our determination that behavioral responses of mysticetes to LFA sonar and other active acoustic sources are unlikely to have any measurable adverse impact on the long-term fitness or reproductive success of individual animals or long-term adverse population-level effects. Although Goldbogen et al. (2013) speculates that “frequent exposures to mid-frequency anthropogenic sounds may pose significant risk to the recovery rates of endangered blue whale populations,” the authors acknowledge that the actual responses of individual blue whales to simulated mid-frequency sonar documented in the study “typically involves temporary avoidance responses that appear to abate quickly after sound exposure.” Moreover, the most significant response documented in the study occurred not as a result of exposure to sonar but as a result of exposure to pseudo-random noise. Therefore, the overall weight of scientific evidence indicates that substantive behavioral responses by mysticetes, if any, from exposure to military sonar are likely to be temporary and are unlikely to have any long-term adverse impact on individual animals or affected populations.

As discussed above, recent efforts have been made to understand the linkage between a stressor, such as anthropogenic sound, and its immediate behavioral or physiological consequences for the individual, and then the subsequent effects on that individual’s vital rates (growth, survival, and reproduction), and the consequences, in turn, for the population.

With respect to threatened and endangered marine mammals, our conclusion that the annual predicted behavioral takes resulting from exposure to SURTASS LFA sonar continuing into the reasonably foreseeable future, are unlikely to result in accumulated adverse impacts is consistent with the negligible impact analysis and determination contained in the proposed MMPA rulemaking, which is incorporated by reference. See 82 FR 19519 to 19522.

Our assessment that the continuation of the Navy's SURTASS LFA sonar routine training, testing, and military operations into the foreseeable future is unlikely to have any adverse additive or long-term impacts on the affected threatened or endangered species (assuming current levels of activity and no significant changes in the status of species or to the environmental baseline) is also consistent with the absence of any documented population-level or adverse aggregate impacts resulting from Navy operations to date, despite more than a decade of Navy SURTASS LFA sonar use. Most of the SURTASS LFA sonar routine training, testing, and military operations are similar, if not identical, to activities that have been occurring in the same locations for decades.

7.7 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). 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, NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. Operation of SURTASS LFA sonar is restricted to sound levels less than 180 dB within the territorial waters of the United States, indicating that the vast majority of the action area is outside the territorial waters of the United States of America, which would preclude the possibility of future state, tribal, or local action that would not require some form of federal funding or authorization. NMFS conducted electronic searches of Google and other electronic search engines. We are not aware of any state or private entities that are likely to occur in the action area during the foreseeable future that were not considered in the *Environmental Baseline* section of this opinion.

7.8 Integration and Synthesis

The *Integration and Synthesis* section is the final step in our assessment of the risk posed to species and designated critical habitat as a result of implementing the proposed action. In this section, we add the *Effects of the Action* (section 7) to the *Environmental Baseline* (section 6) and the *Cumulative Effects* (section 7.7) 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 an 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 Endangered Species Act-Listed Resources* (section 5).

The following discussions separately summarize the probable risks the proposed action poses to ESA-listed species and designated 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.

Our *Integration and Synthesis* for ESA-listed marine mammals is divided into two sections. The first section considers ESA-listed species that will be affected by SURTASS LFA sonar operations in the 2017 through 2018 annual period and in future years should the Navy not change where SURTASS LFA operations occur, and the other considers ESA-listed species that will not be exposed to SURTASS LFA sonar in the first year of Navy activities considered in this opinion, but could be impacted in future years should the Navy decide to change where SURTASS LFA sonar is operations occur.

7.8.1 Marine Mammal Species Affected

The following species occur in, and are expected to be exposed to, SURTASS LFA sonar in the 15 mission areas of the western and central North Pacific Ocean and Indian Ocean proposed for the 2017 through 2018 annual period, and in future years should the Navy not change where SURTASS LFA is operated. Some of these species also occur in other regions where the U.S. Navy could operate in future years. NMFS did not estimate the number of individuals of these species from the proposed operation of SURTASS LFA sonar for these other areas because such an estimate necessarily depends on factors such as location and season of operation. However, the Navy will ensure that no more than 12 percent of any marine mammal species or stock would be taken by Level B harassment under the MMPA annually from all SURTASS LFA sonar transmission on all four vessels.

Based on the Navy's operational history, we assumed that the Navy's SURTASS LFA sonar operations will continue to be used in these same mission areas for the duration of the five-year proposed action and into the reasonably foreseeable future, and that take will occur in subsequent years, by Level B harassment, in the same mission areas proposed for the first year at levels no higher than proposed in the Navy's biological evaluation (Navy 2016) and as referenced in the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels). As noted in sections 2.1.7 and 2.4 above, if the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, such a change would require additional consultation under section 7 of the ESA that tiers off of the programmatic analysis in this consultation.

7.8.1.1 *Blue Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of blue whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 17 instances of blue whale behavioral harassment from SURTASS LFA sonar operations. The individuals affected would be from the Western North Pacific, the Central North Pacific – Hawaii, North Indian, and South Indian stocks of blue whales. The 17 instances of harassment (TTS and behavioral response) would result in less than 0.01 percent of the Western North Pacific stock, 2.17 percent of the Central North Pacific – Hawaii stock, 0.02 of the North Indian stock, and 0.03 of the South Indian stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that these same stocks will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, blue whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 1998 blue whale recovery plan does not outline downlisting or delisting criteria. The recovery plan does list several stressors potentially affecting the status of blue whales in the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea that are relevant to SURTASS LFA sonar activities including: vessel strike, vessel disturbance, and military operations (including sonar). At the time the recovery plan was published, the effects of these stressors on blue whales in the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea were not well documented, their impact on recovery was not understood, and no attempt was made to prioritize the importance of these stressors on recovery. As described previously, anthropogenic noise associated with SURTASS LFA sonar operations is not expected to impact the fitness of any individuals of this species. No mortality of blue whales is expected to occur from SURTASS LFA sonar operations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of blue whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of blue whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.2 *False Killer Whale – Main Hawaiian Islands Insular Distinct Population Segment*

In determining whether Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of Main Hawaiian Islands Insular DPS of false killer whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections in this opinion, several threats have been identified that may have or continue to lead to the decline of Main Hawaiian Islands Insular DPS false killer whales. These include incidental interactions with commercial and recreational fisheries and aquaculture facilities, prey availability, vessel traffic, anthropogenic noise, small population effects, disease and predation, parasitism, environmental contaminants, harmful algal blooms, and ocean acidification, and climate change (Oleson et al. 2010a). Also, reduced genetic diversity may be a natural, but partially anthropogenically induced factor leading to Main Hawaiian Islands Insular DPS of false killer whale decline (Wearmouth and Sims 2008). The current abundance trend for Main Hawaiian Islands Insular DPS of false killer whales in the action area is not well understood. Some data indicate a slight increase.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately seven instances of Main Hawaiian Islands Insular DPS of false killer whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The seven instances of harassment would result in 3.7 percent of the DPS being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that Main Hawaiian Islands Insular DPS false killer whales, like other toothed whales, are not very sensitive to low-frequency sounds. Despite the limited number of studies, the available evidence suggests that the risk of injury, significant masking, stranding, resonance effects, or behavioral effects in these whales is very low. The best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Main Hawaiian Islands Insular DPS of false killer whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Main Hawaiian Islands Insular DPS of false killer whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.3 *Fin Whale*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of fin whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats of the survival and recovery of fin whales have been whaling and ship strikes. The threat of whaling has been eliminated. The current abundance trend for fin whales rangewide including the action area is not well understood.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 284 instances of fin whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The individuals affected would be from the Western North Pacific, East China Sea, Hawaii, North Indian, and South Indian stocks of fin whales. The 284 instances of harassment would result in 2.59 percent of the Western North Pacific stock, 1.81 percent of the East China Sea stock, 2.01 percent of the Hawaii stock, 0.43 of the North Indian stock, and 0.04 of the South Indian stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that these same stocks will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, fin whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2010 fin whale recovery plan defines three recovery populations by ocean basin (i.e., North Atlantic, North Pacific, and Southern Hemisphere) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, direct harvest, anthropogenic noise, and ship collision. Of these, anthropogenic noise and ship collision are relevant to SURTASS LFA sonar operations. As discussed previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. Downlisting criteria for fin whales includes the maintenance of at least 250 mature females and 250 mature males in each recovery population, which is already exceeded in the North Pacific. To qualify for downlisting, each recovery population must also have no more than a one percent chance of extinction in 100 years. To qualify for delisting, each recovery population must also have no more than a ten percent chance of becoming endangered in 20 years. To our knowledge, a population viability analysis has not been conducted on fin whale recovery populations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of fin whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of fin whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.4 *Gray Whale – Western North Pacific Population*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are not likely to jeopardize the survival and recovery of the Western North Pacific population of gray whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of the Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Western North Pacific population of gray whales have been whaling and ship strikes. The threat of whaling has been eliminated. The current abundance trend of Western North Pacific population of gray whales rangewide including the action area is not well understood.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately four instances of Western North Pacific population of gray whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The four instances of harassment would result in 0.46 percent of the Western North Pacific population being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this population will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in sections 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, gray whales from the Western North Pacific population, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. There is currently no recovery plan for the Western North Pacific population of gray whale.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of gray whales from the Western North Pacific population in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of gray whales from the Western North Pacific population in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.5 *Humpback Whale – Arabian Sea Distinct Population Segment*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of Arabian Sea DPS of humpback whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of the Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of the Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of humpback whales have been whaling, fisheries interactions (including entanglement), and ship strikes. The threat of whaling has been eliminated.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately one instance of Arabian Sea DPS humpback whale harassment from SURTASS LFA sonar operations. The one instance of harassment (TTS and behavioral response) would result in 0.14 percent of the Arabian Sea DPS being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, Arabian Sea DPS of humpback whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The general increase in the number of humpback whales range-wide suggests that the stress regime these whales are exposed to including activities in the action area have not prevented these whales from increasing their numbers. Humpback whales have been exposed to Navy SURTASS LFA routine training, testing, and military operations in the action area for more than a generation. The 1991 humpback whale recovery plan does not outline specific downlisting and delisting criteria. The recovery plan does list several threats known or suspected of impacting humpback whale recovery including subsistence hunting, commercial fishing stressors, habitat degradation, loss of prey species, ship collision, and acoustic disturbance. Of these, ship collision and acoustic disturbance are relevant to SURTASS LFA sonar operations. As described previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. No mortality of Arabian Sea DPS of humpback whales is expected to occur from SURTASS LFA sonar operations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Arabian Sea DPS of humpback whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Arabian Sea DPS of humpback whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.6 *Humpback Whale – Western North Pacific Distinct Population Segment*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of Western North Pacific DPS of humpback whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baselin*e that has led to the current *Status of the Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of the Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of humpback whales have been whaling, fisheries interactions (including entanglement), and ship strikes. The threat of whaling has been eliminated.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 149 instances of Western North Pacific DPS humpback whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The 149 instances of behavioral harassment would result in 11.15 percent of the Western North Pacific DPS being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, Western North Pacific DPS of humpback whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The general increase in the number of humpback whales range-wide suggests that the stress regime these whales are exposed to including activities in the action area have not prevented these whales from increasing their numbers. Humpback whales have been exposed to Navy SURTASS LFA routine training, testing, and military operations in the action area for more than a generation. The 1991 humpback whale recovery plan does not outline specific downlisting and delisting criteria. The recovery plan does list several threats known or suspected of impacting humpback whale recovery including subsistence hunting, commercial fishing stressors, habitat degradation, loss of prey species, ship collision, and acoustic disturbance. Of these, ship collision and acoustic disturbance are relevant to SURTASS LFA sonar operations. As described previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. No mortality of Western North Pacific DPS of humpback whales is expected to occur from SURTASS LFA sonar operations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects,* stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Western North Pacific DPS of humpback whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Western North Pacific DPS of humpback whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.7 *North Pacific Right Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of North Pacific right whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of North Pacific right whales have been whaling, fisheries interactions (including entanglement), and ship strikes. The threat of whaling has been eliminated. The current abundance trend for North Pacific right whales rangewide including the action area is not well understood.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 15 instances of North Pacific right whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The 15 instances of behavioral harassment would result in 1.26 percent of the Western North Pacific stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, North Pacific right whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2013 North Pacific right whale recovery plan defines two recovery populations in the North Pacific Ocean (the western and eastern) and sets criteria for the downlisting and delisting of this species. The recovery plan lists several stressors potentially affecting the status of North Pacific right whales that are relevant to SURTASS LFA sonar operations including vessel disturbance and military operations (including sonar). As discussed previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. Downlisting criteria for North Pacific right whales includes the maintenance of at least 250 mature females and 250 mature males in each recovery population. To quantify for downlisting, each recovery population must also have no more than a one percent chance of extinction in 100 years. To qualify for delisting, each recovery population must also have no more than a ten percent chance of becoming endangered in 25 years. To our knowledge, a population viability analysis has not been conducted on North Pacific right whale recovery populations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of North Pacific right whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of North Pacific right whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.8 *Sei Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of sei whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of sei whales have been whaling and ship strikes. The threat of whaling has been eliminated. The current abundance trend for sei whales rangewide including the action area is not well understood.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 457 instances of sei whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The individuals affected would be from the North Pacific and Hawaii stocks of sei whales. The 457 instances of harassment would result in 6.34 percent of the North Pacific stock and 2.0 percent of the Hawaii stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that these same species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, sei whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2011 sei whale recovery plans defines three recovery populations by ocean basin (the North Atlantic, North Pacific, and Southern Hemisphere) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, direct harvest, anthropogenic noise, and ship collision. Of these, anthropogenic noise and ship collision are relevant to SURTASS LFA sonar operations. As described previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. Downlisting criteria for sei whales includes the maintenance of 1,500 mature, reproductive individuals with at least 250 mature females and 250 mature males in each recovery population, which is already exceeded in the North Pacific. To qualify for downlisting, each recovery population must also have no more than a one percent chance of extinction in 100 years. To qualify for delisting, each recovery population must also have no more than a ten percent chance of becoming endangered in 20 years. To our knowledge, a population viability analysis has not been conducted on sei whale recovery populations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of sei whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of sei whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.9 *Sperm Whale*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of sperm whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental*

Baseline that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of sperm whales have been whaling, entanglement in fishing gear, and ship strikes. The threat of whaling has been eliminated. The current abundance trend for sperm whales rangewide including the action area is not well understood.

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 608 instances of sperm whale harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The 608 instances of behavioral harassment would result in 0.44 percent of the North Pacific stock, 0.96 percent of the Hawaii stock, 0.33 percent of the North Indian stock, and 0.03 of the South Indian stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that these same stocks will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that sperm whales, like other toothed whales, are not very sensitive to low-frequency sounds. Despite the limited number of studies, the available evidence suggests that the risk of injury, significant masking, stranding, resonance effects, or behavioral effects in these whales is very low. The best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2010 sperm whale recovery plan defines three recovery populations by ocean basin (the Atlantic Ocean/Mediterranean Sea, Pacific Ocean, and Indian Ocean) and sets criteria for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with fisheries, climate change, and direct harvest, oil spills, anthropogenic noise, and ship collision. Of these, anthropogenic noise and ship collision are relevant to SURTASS LFA sonar operations. As discussed previously, anthropogenic noise associated with SURTASS LFA sonar operations will not impact the fitness of any individuals of this species. Downlisting criteria for sperm whales includes the maintenance of 1,500 mature, reproductive individuals with at least 250 mature females and 250 mature males in each recovery population, which is already exceeded in the Atlantic Ocean, Indian Ocean, and Pacific Ocean. To qualify for downlisting, each recovery population must also have no more than one percent chance of extinction in 100 years. To qualify for delisting, each recovery population must also have no more than a ten percent chance of becoming endangered in 20 years. To our knowledge, a population viability analysis has not been conducted on sperm whale recovery populations.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of sperm whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of sperm whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.10 *Hawaiian Monk Seal*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Hawaiian monk seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resource*s and *Environmental Baseline* sections of this opinion, several threats have been identified that may have or continue to lead to the decline of Hawaiian monk seals. Hawaiian monk seals are threatened by natural predation, disease outbreaks, biotoxins, and agonistic behavior by male Hawaiian monk seals (NMFS 2011e). Hawaiian monk seals, particularly pups, are also subjected to extensive predation by sharks, which appear to be a significant problem for the Hawaiian monk seals occupying French Frigate Shoals in the Northwest Hawaiian Islands (Antonelis et al. 2006). One of the most substantial threats to Hawaiian monk seals results from dramatic declines in the survival of juveniles and appears to be related to significantly reduced body sizes in pup and juvenile animals. Several human activities are known to threaten Hawaiian monk seals: commercial and subsistence hunting, intentional harassment, competition with commercial fisheries, entanglement in fishing gear, habitat destruction on breeding beaches, pollution, and unintentional human disturbance (Kenyon 1981; Reeves et al. 1992; Riedman 1990). The revised recovery plan for Hawaiian monk seals identified food limitation, entanglements, and shark predation as crucial threats to the continued existence of this species (NMFS 2007c).

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 17 instances of Hawaiian monk seal harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The 17 instances of behavioral harassment would result in 1.12 percent of the Hawaii stock being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, Hawaiian monk seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2007 Hawaiian monk seal recovery plan defines seven recovery populations, the French Frigate Shoals, Lisianski Island, Midway Atoll, Laysan Island, Pearl and Hermes Reef, Kure Atoll, and Main Hawaiian Islands, and sets criteria, for the downlisting and delisting of this species. Both downlisting and delisting requirements include abatement of threats associated with food limitation, debris entanglement, predation, fisheries, erosion, and disease. None of these stressors have been determined to be relevant to SURTASS LFA sonar operations with regards to this species. Downlisting criteria for Hawaiian monk seals includes the maintenance of 2,900 individuals in the Northwestern Hawaiian Islands, at least five of the six Northwestern Hawaiian Islands sub-populations with at least 100 individuals and the Main Hawaiian Island population above 500 individuals, and a population growth rate of zero or higher. To quantify for delisting, the downlisting criteria must be met for 20 consecutive years. As described previously, we conclude the temporary effects from acoustic stressors associated with Navy SURTASS LFA sonar operations will not impact the fitness of any individuals of this species or the populations to which they belong.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Hawaiian monk seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Hawaiian monk seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.11 *Spotted Seal – Southern Distinct Population Segment*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Southern DPS of spotted seals, we assessed effects of the action against aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, several threats have been identified that may have or continue to lead to the decline of Southern DPS of spotted seals. Southern DPS of spotted seals have long been a target of commercial and subsistence hunting, but threats from climate change and environmental contaminants are more recent developments. Although significant direct effects from climate change are not expected, indirect effects can be important (Boily 1995; Grebmeier et al. 2006; Harding et al. 2005). These include changes in prey abundance or distribution, predation, and disease (Boveng et al. 2009a; Comeau et al. 2009; Grebmeier et al. 2006). Additionally, Southern DPS of spotted seals are still hunted for meat, fur, oil, and animal feed by coastal inhabitants of the northern Pacific rim (Fedoseev 1984; Krylov et al. 1964).

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately 2 instances of Southern DPS spotted seal harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The two instances of harassment would result in 0.02 percent of the Southern DPS being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the

MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, Southern DPS of spotted seal, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Southern DPS of spotted seal.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Southern DPS of spotted seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Southern DPS spotted seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.1.12 *Steller Sea Lion – Western Distinct Population Segment*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Western DPS of Steller sea lions, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, several threats have been identified that may have or continue to lead to the decline of Western DPS of Steller sea lions including, but not limited to, harvest, competition for prey with fisheries, and contaminants. The current abundance trend for Western

DPS of Steller sea lions rangewide including the action area is likely still in decline (though the decline has slowed or stopped in some portions of the range).

In the first year of the proposed action, assuming the Navy conducts the maximum extent of routine training, testing, and military operations in a year, there will be approximately two instances of Western DPS of Steller sea lion harassment (TTS and behavioral response) from SURTASS LFA sonar operations. The two instances of harassment would result in less than 0.01 percent of the Western DPS being affected by SURTASS LFA sonar transmissions the first year. Based on the Navy's operational history, we assume that this species will experience Level B harassment from SURTASS LFA sonar at levels no higher than those proposed in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption (i.e., no more than 12 percent of any marine mammal stock will be taken by Level B harassment, as defined by the MMPA, annually from all SURTASS LFA sonar transmission on all four vessels) for the duration of the five-year proposed action and into the reasonably foreseeable future.

As described further in section 7.3 and 7.6, the evidence available suggests that when exposed to SURTASS LFA sonar transmissions, Western DPS of Steller sea lions, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

The 2008 Steller sea lion revised recovery plan defines seven recovery sub-region populations, the Eastern Gulf of Alaska, Central Gulf of Alaska, Western Gulf of Alaska, Eastern Aleutian Islands, Central Aleutian Islands, Western Aleutian Islands, and Russia/Asia, and sets criteria, for the downlisting and delisting of this species. Downlisting criteria for Western DPS of Steller sea lions includes that the population for the U.S. region has increased for 15 years on average, based on counts of non-pups (i.e., juveniles and adults); the trends in non-pups in at least five of the seven sub-regions are consistent with the trend observed, the population trend in any two adjacent sub-regions cannot be declining significantly. To quantify for delisting, the population for the U.S. regions for Western DPS of Steller sea lions has increased for 30 years based on counts of non-pups (i.e., juveniles and adults); the trends in non-pups in at least five of the seven sub-regions are stable or increasing, the population trend in any two adjacent sub-regions cannot be declining significantly, the population trend in any sub-region cannot have declined by more than 50 percent.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Western DPS of Steller sea lions in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Western DPS of Steller sea lions in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2 Other Marine Mammal Species Considered in the Navy Action

The following species do not occur in the mission areas proposed for the first year of the Navy's action and will not be exposed to SURTASS LFA sonar from August 2017 through August 2018. These species are considered in this opinion because they occur in the non-polar regions of the world's oceans and could be exposed to SURTASS LFA sonar in future years should the Navy change the area where they operate SURTASS LFA sonar to a location where this species occurs. NMFS did not estimate the amount of take (the number of individuals) of these species from the proposed operation of SURTASS LFA sonar because no missions were proposed in areas where these species occur for the first year and such an estimate necessarily depends on factors such as location and season of operation. However, we do know that for marine mammals, the figure will not exceed 12 percent annually for any particular stock of endangered or threatened species.

In future years, should the Navy propose to operate in mission areas not proposed for the first year, subsequent consultation under section 7 of the ESA would be required.

7.8.2.1 *Bowhead Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of bowhead whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats of the survival and recovery of bowhead whales have been whaling, fisheries interactions, contaminants, noise, and ship strikes. The threat of whaling has been eliminated. The current abundance trend for bowhead whales rangewide including the action area is increasing.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could affect bowhead whales, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, bowhead whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses or instances of TTS that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the bowhead whale.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of bowhead whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of bowhead whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.2 *Bryde's Whale – Gulf of Mexico Sub-Species*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of Gulf of Mexico sub-species of Bryde's whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats of the survival and recovery of Gulf of Mexico sub-species of Bryde’s whales have been whaling, oil and gas exploration and production, oil spills, entanglement, and ship strikes. The threat of whaling has been eliminated. The current abundance trend for Gulf of Mexico sub-species of Bryde’s whales rangewide including the action area is not well understood.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect the Gulf of Mexico sub-species of Bryde’s whales, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, the Gulf of Mexico subspecies of Bryde’s whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as proposed pursuant to the ESA that could be readily perceived or estimated. No recovery plan has been prepared for the Gulf of Mexico sub-species of Bryde’s whales as the species is currently proposed for listing under the ESA.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of the Gulf of Mexico sub-species of Bryde’s whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of the Gulf of Mexico subspecies of Bryde’s whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.3 *Humpback Whale – Cape Verde Islands/Northwest Africa, Central America, and Mexico Distinct Population Segments*

In determining whether the Navy’s SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of humpback whales from the Cape Verde Islands/Northwest Africa, Central America, and Mexico DPSs, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baselin*e that has led to the current *Status of the Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

While we are unable to estimate the amount or extent of take of these species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect these species, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, humpback whales from these DPSs, like other humpback whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of these species as listed pursuant to the ESA that could be readily perceived or estimated.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects,* stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of humpback whales from the Cape Verde Islands/Northwest Africa, Central America, and Mexico DPSs in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of humpback whales from these DPSs in the wild by reducing the reproduction, numbers, or distribution of these species.

7.8.2.4 *Killer Whale – Southern Resident Distinct Population Segment*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of Southern Resident DPS of killer whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baselin*e that has led to the current *Status of the Endangered*

Species Act-Listed Resources and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of the Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Southern Resident DPS of killer whales have been contaminants, vessel traffic, and reduced prey. The threat of whaling has been eliminated. Southern Resident DPS of killer whale abundance has recently declined and the population status is unstable.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Southern Resident DPS of killer whales, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that Southern Resident DPS killer whales, like other toothed whales, are not very sensitive to low-frequency sounds. Despite the limited number of studies, the available evidence suggests that the risk of injury, significant masking, stranding, resonance effects, or behavioral effects in these whales is very low. The best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect acoustic stressors to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Southern Resident DPS killer whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of bowhead whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.5 *North Atlantic Right Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of North Atlantic right whales, we assessed effects of the action against the aggregate effects of everything in the

Environmental Baseline that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of North Atlantic right whales have been whaling, ship strikes, and entanglement in fishing gear. The threat of whaling has been eliminated. Substantial progress has been made in mitigating ship strikes by regulating vessel speeds, but entanglement in fishing gear remains a major threat. The current abundance trend for North Atlantic right whales had been positive, but may now be in decline.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect North Atlantic right whales, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, North Atlantic right whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of North Atlantic right whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of North Atlantic right whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.6 *South Island Hector's Dolphin*

In determining whether Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of South Island Hector's dolphin, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections in this opinion, several threats have been identified that may have or continue to lead to the decline of South Island Hector's dolphin. These include incidental interactions with commercial and recreational fisheries, habitat modification and degradation, disease, and tourism. The current abundance trend for South Island Hector's dolphins in the action area shows evidence of a declining population.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect South Island Hector's dolphins, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests Hector's dolphins, like other cetaceans, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as proposed pursuant to the ESA that could be readily perceived or estimated. No recovery plan has been prepared for the South Island Hector's dolphin as the species is currently proposed for listing under the ESA.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of South Island Hector's dolphin in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of South Island Hector's dolphin in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.7 *Southern Right Whale*

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of North Pacific right whales, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Southern right whales have been whaling and ship strikes. The threat of whaling has been eliminated. The abundance of Southern right whales rangewide including the action area is increasing at a robust rate.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Southern right whales, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, southern right whales, like other baleen whales, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual whales exposed. An action that is not likely to reduce the fitness of individual whales is not likely to reduce the viability of the populations those individual whales comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Southern right whale.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Southern right whales in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of southern right whales in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.8 ***Bearded Seal – Okhotsk Distinct Population Segment***

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Okhotsk DPS of bearded seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Okhotsk DPS bearded seals, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, Okhotsk DPS bearded seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Okhotsk DPS of bearded seal.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Okhotsk DPS bearded seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Okhotsk DPS of bearded seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.9 *Guadalupe Fur Seal*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Guadalupe fur seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Guadalupe fur seals, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, Guadalupe fur seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has been not prepared a recovery plan for Guadalupe fur seals

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Guadalupe fur seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Guadalupe fur seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.10 *Mediterranean Monk Seal*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Mediterranean monk seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resource*s and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Mediterranean monk seals have been harvest for human use and interactions with fisheries (including entanglement). Commercial hunting has ceased. The current abundance trend for Mediterranean monk seals rangewide including the action area is unknown.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Mediterranean monk seals, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, Mediterranean monk seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Mediterranean monk seal.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Mediterranean monk seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Mediterranean monk seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.11 *Ringed Seal – Arctic Distinct Population Segment*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Arctic DPS of ringed seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resource*s and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Arctic DPS of ringed seals have been subsistence harvest, disturbance from vessels, sound from seismic exploration, and oil spills. The current abundance trend for Arctic DPS of ringed seals rangewide including the action area is apparently stable; however, it is threatened by future climate change and loss of habitat and prey availability.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Arctic DPS of ringed seals, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, Arctic DPS of ringed seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Arctic DPS of ringed seal.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of Arctic DPS of ringed seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of Arctic DPS of ringed seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.2.12 *Ringed Seal – Okhotsk Distinct Population Segment*

In determining whether the Navy SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of the Okhotsk DPS of ringed seal, we assessed effects of the action against the aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resource*s and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to the survival and recovery of Okhotsk DPS of ringed seals have been subsistence harvest, fisheries interactions (including entanglement), disturbance from vessels, sound from seismic exploration, and oil spills. The current abundance trend for the Okhotsk DPS of ringed seals rangewide including the action area is apparently stable; however, it is threatened by future climate change and loss of habitat and prey availability.

While we are unable to estimate the amount or extent of take of this species that could occur in future years, we can assess the currently available information to determine how SURTASS LFA sonar could effect Okhotsk DPS of ringed seals, if individuals were to be exposed. As described further in section 7.3 and 7.6, the evidence available suggests that if exposed to SURTASS LFA sonar transmissions in future years, Okhotsk DPS of ringed seals, like other pinnipeds, are not likely to be killed or experience injury, significant masking, stranding, resonance effects, or behavioral responses that might reduce the longevity or reproductive success of individuals that have been exposed. Instead, the best scientific and commercial data available suggests that SURTASS LFA sonar transmissions are likely to elicit short-term behavioral responses that are not likely to impact the fitness of the individual seals exposed. An action that is not likely to reduce the fitness of individual seals is not likely to reduce the viability of the populations those individual seals comprise (that is, we would not expect reductions in the reproduction, numbers, or distribution of those populations) and therefore, we do not expect exposure to SURTASS LFA sonar to result in substantial changes in reproduction, numbers, or distribution of these populations. By the same logic, we do not anticipate any reductions in survival rate or trajectory of recovery of the species as listed pursuant to the ESA that could be readily perceived or estimated. NMFS has not prepared a recovery plan for the Okhotsk DPS of ringed seal.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area (see section 2.2) on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of the Okhotsk DPS of ringed seals in the wild by reducing the reproduction, numbers, or distribution of that species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of the Okhotsk DPS of ringed seals in the wild by reducing the reproduction, numbers, or distribution of that species.

7.8.3 Threatened and Endangered Sea Turtles

In determining whether the Navy's SURTASS LFA sonar routine training, testing, and military operations in the action area are likely to jeopardize the survival and recovery of ESA-listed sea turtles (North Atlantic DPS, Mediterranean DPS, South Atlantic DPS, Southwest Indian DPS, North Indian DPS, East Indian-West Pacific DPS, Central West Pacific DPS, Southwest Pacific DPS, Central South Pacific DPS, Central North Pacific DPS, and East Pacific DPS of green turtle; hawksbill turtle; Kemp's ridley turtle; leatherback turtle; Mediterranean Sea DPS, Northeast Atlantic Ocean DPS, Northwest Atlantic Ocean DPS, North Indian Ocean DPS, North Pacific Ocean DPS, South Atlantic Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle; and olive ridley turtle), we assessed effects of the action against aggregate effects of everything in the *Environmental Baseline* that has led to the current *Status of Endangered Species Act-Listed Resources* and, those effects of future non-Federal activities that are reasonably certain to occur within the action area in the reasonably foreseeable future.

As described in the *Status of Endangered Species Act-Listed Resources* and *Environmental Baseline* sections of this opinion, some of the primary anthropogenic threats to ESA-listed sea turtles are fisheries interactions, climate change, and impacts to terrestrial nesting habitat. SURTASS LFA sonar (or other military sonars) has not been identified as a primary threat to ESA-listed sea turtles.

Only sea turtle species that occur in the 15 operational areas listed in Table 60 are expected to be exposed to SURTASS LFA sonar during the 2017 through 2018 annual period. The Navy can only predict the level and general location (i.e., mission areas) of SURTASS LFA sonar operations for a one-year period into the future. However, these levels and locations have changed minimally since 2002. Based on the Navy's operational history, this consultation assumes that the Navy's SURTASS LFA sonar operations will continue to be used in these same mission areas for the duration of the five-year action and into the reasonably foreseeable future. Therefore, we expect that the sea turtle species that occur in the 15 operational areas listed in Table 60 are expected to be exposed to SURTASS LFA sonar in future years as well. However, since under the proposed five-year action, the Navy may operate in all non-polar areas of the Pacific, Indian, and Atlantic Oceans and Mediterranean Sea, any sea turtle species that reside in these areas could be exposed to and affected by SURTASS LFA sonar in future years. This includes all sea turtle species and DPSs considered in this opinion (Table 46). As described previously, if the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, subsequent consultation under section 7 of the ESA would be required.

Due to the lack of more definitive data on sea turtle population distributions in the open ocean, we were not able to estimate the percentage of a sea turtle population (or number of individuals) that could be exposed to SURTASS LFA sonar sound transmission. Instead, we quantified the extent of take of sea turtles due to the operation of SURTASS LFA sonar. We determined that the likelihood of sea turtles experiencing mortality, injury (including PTS), or TTS from SURTASS LFA sonar is discountable, but that that sea turtles exposed to sound pressure levels at or above 175 dB during SURTASS LFA sonar operations would be likely to exhibit a behavioral response that would rise to the level of take under the ESA. However, we anticipate sea turtles exposed to LFA sonar would not exhibit long-term behavioral responses that could impact an individual's fitness. Because we do not expect instances of behavioral harassment to result in fitness consequences to individual ESA-listed sea turtles, we do not expect population level effects from exposure to SURTASS LFA sonar.

Based on the evidence available, including the *Environmental Baseline* and *Cumulative Effects*, stressors resulting from the Navy SURTASS LFA sonar routine training, testing, and military operations that will be conducted in the action area on an annual basis and for the reasonably foreseeable future (assuming there are no significant changes to the *Status of Endangered Species Act-Listed Resources* or *Environmental Baseline*), would not be expected, directly or indirectly, to appreciably reduce the likelihood of the survival of any ESA-listed species of sea turtle in the wild by reducing the reproduction, numbers, or distribution of those species. We also conclude that effects from ongoing Navy SURTASS LFA sonar routine training, testing, and military operations continuing into the reasonably foreseeable future would not be expected, directly or indirectly, to appreciably reduce the likelihood of recovery of any ESA-listed species of sea turtle in the wild by reducing the reproduction, numbers, or distribution of those species.

8 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 (Navy SURTASS LFA sonar routine training, testing, and military operations from August 2017 through August 2022 and into the reasonably foreseeable future) is not likely to jeopardize the continued existence of the blue whale; bowhead whale; proposed Gulf of Mexico DPS of Bryde's whale; Main Hawaiian Islands Insular DPS of false killer whale; fin whale; Western North Pacific population of gray whale; Arabian Sea DPS, Cape Verde/Northwest Africa DPS, Central America DPS, Mexico DPS, and Western North Pacific DPS of humpback whale; Southern Resident DPS of killer whale; North Atlantic right whale; North Pacific right whale; sei whale; proposed South Island Hector's dolphin; Southern right whale; sperm whale; Okhotsk DPS of bearded seal; Guadalupe fur seal; Hawaiian monk seal; Mediterranean monk seal; Okhotsk DPS of ringed seal; Southern DPS of spotted seal; Western DPS of Steller sea lion; North Atlantic DPS, Mediterranean DPS, South Atlantic DPS, Southwest Indian DPS, North Indian DPS, East Indian-West Pacific DPS, Central West Pacific DPS, Southwest Pacific DPS, Central South Pacific DPS, Central North Pacific DPS, and East Pacific DPS of green turtle; hawksbill turtle; Kemp’s ridley turtle; leatherback turtle; Mediterranean Sea DPS, Northeast Atlantic Ocean DPS, Northwest Atlantic Ocean DPS, North Indian Ocean DPS, North Pacific Ocean DPS, South Atlantic Ocean DPS, South Pacific Ocean DPS, Southeast Indo-Pacific Ocean DPS, and Southwest Indian Ocean DPS of loggerhead turtle; and olive ridley turtle and not likely to destroy or adversely modify designated critical habitat for the North Atlantic right whale, North Pacific right whale, Hawaiian monk seal, Western DPS of Steller sea lion, leatherback turtle, and loggerhead turtle.

9 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. 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 has not yet defined “harass” under the ESA in regulation.

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.” Under the MMPA, Level B harassment for military readiness activities, such as the activities analyzed in this consultation, is defined as “any act that disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering, to a point where such behavioral patterns are abandoned or significantly altered.” For purposes of this consultation, we relied on NMFS’ interim definition of harassment to evaluate when the proposed activities are likely to harass ESA-listed sea turtle species. For marine mammals, we relied on the MMPA definition of Level B harassment in the context of military readiness activities to estimate the number of instances of harassment. For further explanation, see section 6 of this opinion.

ESA section 7(b)(4) states that take of ESA-listed marine mammals must be authorized under MMPA section 101(a)(5) before the Secretary can issue an incidental take statement for ESA-listed marine mammals. NMFS’s implementing regulations for MMPA section 101(a)(5)(A) specify that a letter of authorization is required to conduct activities pursuant to any regulations for a specific activity that will “take” marine mammals. However, because the National Defense Exemption set forth in 16 U.S.C. §1371(f) has been invoked, the requirements of MMPA section 101(a)(5)(A) are not applicable. Therefore, a take authorization under section 101(a)(5) of the MMPA is not required and ESA section 7(b)(4) does not preclude issuance of an ITS while the National Defense Exemption is in force. Though the National Defense Exemption will remain in force for a maximum of two years from August 13, 2017, this consultation contemplated the full five years of the Navy’s proposed action. We anticipate that upon, or prior to, the expiration of the National Defense Exemption, the National Marine Fisheries Service Permits and Conservation Division will issue Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities. As described below, this incidental take statement exempts take for the first year of the proposed action. Take exemptions for future years will be evaluated on a yearly basis consistent with term and condition number seven. Further, we anticipate that the mitigation, monitoring, and reporting requirements of any Regulations and Letters of Authorization issued under under Title 16, Section 1371 will be consistent with the mitigation, monitoring, and reporting procedures described in the Navy’s biological evaluation (Navy 2016) and National Defense Exemption. If this is not the case, the Navy will have to reinitiate consultation.

Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

9.1 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 CFR §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions while the extent of take or “the extent of land or marine area that may be affected by an action” may be used if we cannot assign numerical limits for animals that could be incidentally taken during the course of an action (51 FR 19953). The amount of take resulting from the Navy’s SURTASS LFA sonar operations was estimated based on the best information available.

The effects analysis in this consultation concluded that marine mammal and sea turtle species are likely to be exposed to, and may be affected by, the active LFA sonar component of the SURTASS LFA sonar operations. In some instances, we concluded that this exposure is likely to result in evasive behavior or changes in behavioral state which we would consider “harassment” for the purposes of this incidental take statement. The instances of harassment for marine mammals and sea turtles would generally represent changes from foraging, resting, milling, and other behavioral states that require lower energy expenditures to traveling, avoidance, and behavioral states that may require higher energy expenditures and, therefore, would represent disruptions of the normal behavioral patterns of the animals that have been exposed. As discussed throughout this opinion, these disruptions are not expected to result in fitness consequences to the animals exposed. No marine mammals or sea turtles are likely to die or be wounded or injured as a result of their exposure to SURTASS LFA sonar.

Under the five-year proposed action, no more than 12 percent of any particular marine mammal stock will be taken by Level B harassment annually and the Navy will observe that limitation under its National Defense Exemption. The incidental “take” of ESA-listed marine mammals for the first year of the proposed action is shown in Table 61 and this ITS exempts take for the first year of the proposed action (through August 2018). However, because the levels and locations of Navy SURTASS LFA sonar operations have changed minimally over time, this consultation assumed that future years of the action (e.g., for years two through five of the action) may result in take of marine mammals, by MMPA Level B harassment, in the same mission areas as those authorized in the first year. While the mission areas are not expected to change, the amount of marine mammal take that is reasonably certain to occur does vary from year to year (although, no more than 12 percent of any particular stock will be taken by Level B harassment annually). This consultation considered the upper limits of potential takes of marine mammals for the duration of the action and assumed, based on Navy's operational history, that the SURTASS LFA sonar mission areas will not change from those proposed in the first year. For future years, the Navy will provide written documentation to NMFS 165 days prior to each annual period of operation describing the SURTASS LFA sonar mission areas for the coming year. Additionally, the Navy will submit a report to NMFS at least 135 days prior to each annual period of operation detailing planned SURTASS LFA sonar operations for the coming year. This report will provide relevant details on SURTASS LFA sonar mission areas and expected levels of take, and describe any changes in SURTASS LFA sonar operations from the previous year. If planned activities are consistent with the activities analyzed in this biological opinion and if the SURTASS LFA sonar mission areas do not change in future years, NMFS will amend this ITS as necessary in order to accommodate year to year variation in the amount of marine mammal take that is reasonably certain to occur. If the Navy were to propose to operate SURTASS LFA sonar in different locations (i.e., missions areas) from those proposed for the first year, such a change could require additional consultation under section 7 of the ESA that tiers off of the programmatic analysis in this consultation.

NMFS is not able to estimate the number of endangered or threatened sea turtles that might be "taken" by the proposed SURTASS LFA sonar operations because such estimates are impossible to produce with current levels of knowledge. In other words, numerical values cannot be practically obtained for these species and DPSs. Although we cannot estimate the amount of take, we can estimate the extent of take of endangered or threatened sea turtles resulting from exposure to LFA sonar. Any anticipated take of endangered or threatened sea turtles that occurs will be in the form of harassment. Permanent or temporary threshold shift is not expected to occur in sea turtles. The anticipated level of take of sea turtles would be exceeded if activity levels as proposed are exceeded, it is determined that a sea turtle remained within 44 m of the LFA sonar for an entire 60-second signal, or if a vessel strike has occurred.

Table 61. The estimated number of instances of Level B (TTS and behavior) harassment (incidental takes) as a result of exposure to Navy SURTASS LFA sonar by mission area number during the 2017 through 2018 annual period.

Species	Estimated Annual Take by Mission Area															Total Estimated Annual Take
Mission Area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Level B Harassment (Behavior and TTS)
Number of Missions	1.5	3	3	3	2	1	1	1	1	1	1	0.5	1	0.5	0.5	-- --
Blue Whale	2	2	2	2	-	-	-	1	1	2	2	1	1	1	-	17
Fin Whale	2	8	7	2	109	10	2	1	1	2	2	8	1	15	114	284
Gray Whale – Western North Pacific Population	-	-	-	-	1	1	1	-	-	-	-	-	-	-	1	4
Humpback Whale – Arabian Sea DPS	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Humpback Whale – WNP DPS	1	48	51	4	-	-	2	1	15	-	-	-	-	-	27	149
North Pacific Right Whale	1	1	-	-	-	1	1	-	-	-	-	-	-	-	11	15
Sei Whale	12	-	-	4	-	-	-	4	115	4	5	-	-	1	312	457

Sperm Whale	32	73	65	53	66	22	16	36	34	27	18	73	11	9	73	608
False Killer Whale – MHI Insular DPS	-	-	-	-	-	-	-	-	-	2	5	-	-	-	-	7
Hawaiian Monk Seal	-	-	-	-	-	-	-	2	-	14	1	-	-	-	-	17
Spotted Seal – Southern DPS	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	2
Steller Sea Lion – Western DPS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Sea Turtles[+]	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

[+] Incidental take is exempted for the following sea turtle species: Green turtle – Central North Pacific, Central West Pacific, East Indian-West Pacific, North Indian DPSs; Hawksbill turtle; Leatherback turtle; Loggerhead turtle – North Indian Ocean, North Pacific Ocean, Southeast Indo-Pacific Ocean DPSs, and Olive ridley turtle.

*Unspecified Number. We do not expect any instances of PTS or TTS in sea turtles. While the potential for behavioral harassment of sea turtles exists, we are not able to estimate the number of sea turtles of each species occurring the action area that could be "taken." Take will exceeded if activity levels as proposed are exceeded or if the monitoring program detects that a sea turtle remained within 44 m of the LFA sonar for an entire 60-second signal, or if a vessel strike occurs

9.2 Activity Levels as an Indicator of Take

As discussed in this opinion, the estimated take of ESA-listed marine mammals from SURTASS LFA sonar is based on Navy modeling, which represents the best available means of numerically quantifying take. As the level of modeled sonar increases, the amount of marine mammal take is likely to increase as well. Feasible monitoring techniques for detecting and calculating actual take at the scale of SURTASS LFA sonar operations do not exist. We are not aware of any other feasible or available means of determining when estimated take levels may be exceeded. Therefore, we must rely on Navy modeling, and the link between sonar use and the amount of take, to determine when anticipated take levels have been exceeded. As such, we established a term and condition of this incidental take statement that requires the Navy to report to NMFS any exceedance of activity levels specified in the preceding opinion before the exceedance occurs if operational security considerations allow, or as soon as operational security considerations allow after the relevant activity is conducted. Exceedance of an activity level will require the Navy to reinitiate consultation.

Detection of behavioral responses of juvenile or adult sea turtles at-sea during Navy SURTASS LFA sonar routine training, testing, or operations would be extremely difficult. Most forms of behavioral responses would not be detected. Also, monitoring techniques to calculate actual take, of including detection and collection of individuals and assessment of injuries or death, is not feasible for sea turtles at the scale of SURTASS LFA sonar operations. Therefore, we must rely on predicted take associated with levels of activities and any opportunistic observations of potential behavioral responses or injured or dead juvenile or adult sea turtles during SURTASS LFA sonar operations as measurements of take and a trigger for reinitiation of consultation. In the absence of observations of unanticipated levels of behavioral responses, injury, or mortality, exceedance of an activity level will require the Navy to reinitiate consultation. Exceedances at the activity level or in other planned events must be reported to NMFS prior to carrying out or as soon as operational security considerations allow, if reporting would interrupt Navy SURTASS LFA sonar routine training, testing, and military operations.

9.3 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 designated critical habitat.

9.4 Reasonable and Prudent Measures

The measures described below are nondiscretionary, and must be undertaken by the U.S. Navy 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 CFR §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:

1. The Navy shall implement a program to mitigate and report the potential effects of SURTASS LFA sonar transmissions on threatened or endangered species of marine mammals and sea turtles.
2. The Navy shall implement a program to monitor potential interactions between SURTASS LFA sonar transmissions and threatened and endangered species of marine mammals and sea turtles.

9.5 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the U.S. Navy must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above and outlines the mitigation, monitoring and reporting measures required by the section 7 regulations (50 CFR §402.14(i)). These terms and conditions are non-discretionary. If the Navy fails 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.

1. The take exemption shall be valid only for the activities associated with the operation of the SURTASS LFA sonar onboard the USNS *IMPECCABLE* (T-AGOS 23), USNS *ABLE* (T-AGOS 20), USNS *EFFECTIVE* (T-AGOS 21), and USNS *VICTORIOUS* (T-AGOS 19). The signals transmitted by the SURTASS LFA sonar source must be between 100 and 500 Hz with a source level for each projector no more than 215 dB re: 1 µPa at 1 m and a maximum duty cycle of 20 percent.
2. The Navy shall: (a) establish shut-down criteria for the SURTASS LFA sonar whenever a marine mammal or other ESA-listed species (i.e., sea turtles) is detected within a one km (0.5 nmi) buffer zone beyond the SURTASS LFA sonar mitigation zone (extent of 180 dB sound field), (b) not broadcast the SURTASS LFA sonar signal at a frequency greater than 500 Hz, and (c) plan its missions to ensure take levels analyzed in this opinion are not exceeded.
3. If a marine mammal or other ESA-listed species is detected within the area subjected to a sound pressure level of 180 dB or greater (mitigation zone) or within the one km (0.5 nmi) buffer zone extending beyond the 180 dB mitigation zone, SURTASS LFA sonar transmissions shall be immediately delayed or suspended. Transmissions shall not resume earlier than 15 minutes after:

   (a) All marine mammals or other ESA-listed species have left the area of the LFA mitigation and buffer zone; and
   (b) There is not further detection of any marine mammal or other ESA-listed species within the LFA mitigation and buffer zones as determined by the visual and/or passive or active acoustic monitoring.
4. The HF/M3 sonar source shall be ramped-up to operating levels over a period of no less than five minutes. The HF/M3 source level shall not be increased if a marine mammal or other ESA-listed species is detected during ramp-up. The HF/M3 ramp-up may continue once marine mammals or other ESA-listed species are no longer detected. The HF/M3 sonar shall be ramped-up:
   (a) At least 30 minutes prior to any SURTASS LFA sonar transmission;
   (b) Prior to any SURTASS LFA sonar calibrations or testing that are not part of regular SURTASS LFA sonar transmissions; and
   (c) Any time after the HF/M3 source has been powered-down for more than two minutes.
5. The SURTASS LFA sonar shall not be operated such that the SURTASS LFA sonar sound field exceeds 180 dB (re: 1µPa [rms]):
   (a) Within 22 km (12 nmi) from any emergent land, including offshore islands; and
   (b) Within one km (0.5 nmi) seaward of the outer perimeter of any designated OBIA during the biologically important season for that particular area.
6. The Navy shall deliver an annual report no later than 45 days after the end of each one year operation period. This report shall include numbers and locations of threatened and endangered species sightings, and all information described in the reporting requirements section of the National Defense Exemption, including the results, if any, of coordination with coastal marine mammal stranding networks. The annual reports shall be submitted to the Chief, ESA Interagency Cooperation Division, 1315 East-West Highway, Silver Spring, Maryland.
7. Except for the first year, the Navy shall provide written notification to NMFS 165 days prior to each annual period of operation describing the SURTASS LFA sonar mission areas for the coming year. Additionally, following the first year, the Navy will submit a report to NMFS at least 135 days prior to each annual period of operation detailing planned SURTASS LFA sonar operations for the coming year. This report will provide relevant details on SURTASS LFA sonar mission areas and expected levels of take, and describe any changes in SURTASS LFA sonar operations from the previous year. The notification and report shall be submitted to the Chief, ESA Interagency Cooperation Division, 1315 East-West Highway, Silver Spring, Maryland.
8. The Navy shall collect specific data on any apparent avoidance reactions of threatened or endangered species in response to exposure to SURTASS LFA sonar transmissions, including the distance from the LFA sonar transmission, conditions of the exposure (location coordinates, depth of the species, time of day, ocean conditions, the animal's behavior before and after the exposure, and estimates of the received levels that elicited

the response). These data must be reported in the annual reports described in condition 6 (above).

9. If the Navy's monitoring program identify any threatened or endangered species that demonstrate acute effects in response to exposure to LFA sonar transmissions, such as injury or death, the Navy shall immediately initiate the source shut-down protocol for the sonar system.
10. The Navy shall carry out all mitigation, monitoring and reporting requirements described in the Navy's biological evaluation (Navy 2016) and the National Defense Exemption.
11. Systematically observe SURTASS LFA sonar operations for injured or disabled marine mammals and monitor the principal marine mammal stranding networks and other media to correlate analysis of any marine mammal strandings that could potentially be associated with SURTASS LFA sonar operations.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the source of the action, the level of incidental take specified in this incidental take statement is exceeded, the Navy must immediately reinitiate consultation and review the reasonable and prudent measures provided. The Navy must immediately provide an explanation, in writing, of the causes of any take and discuss possible modifications to the reasonable and prudent measures with NMFS' ESA Interagency Cooperation Division.

10 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 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 designated critical habitat, to help implement recovery plans or develop information (50 CFR §402.02).

1. We recommend SURTASS LFA sonar environmental compliance efforts integrate more effectively with Navy fleet training and testing environmental compliance efforts, including the development and implementation of acoustic threshold metrics and criteria in modeling efforts, the adaptive management process, and literature review to ensure consistency and to explore efficiencies pertaining to ESA section 7(a)(2).
2. We recommend the Navy consider increasing the detection capability of the area above the HF/M3 sonar system (between the vertical line array and sea surface) and conduct field experiments to update the evaluation of the effectiveness of the HF/M3 sonar system at detecting marine mammals.
3. We recommend the Navy pursue research to determine the effectiveness of the HF/M3 active sonar system at detecting ESA-listed sea turtles and large fish, including coelacanth, giant manta ray, groupers, sharks, sturgeon, and totoaba.

4. We recommend the Navy conduct additional field experiments and research as part of the Low Frequency Sound Scientific Research Program to update the important literature on the effects and responses of ESA-listed marine mammals, sea turtles, and fish.
5. We recommend the Navy use thermal imaging cameras, in addition to binoculars and the naked eye, for use during daytime and nighttime visual observations and test their effectiveness at detecting threatened and endangered species. We recommend the Navy use broader and more comprehensive field guides such as *Marine Mammals of the World, A Comprehensive Guide to Their Identification* (Jefferson et al. 2015) in addition to current regional field guides.
6. During SURTASS LFA sonar operations, the Navy currently conducts passive acoustic monitoring in the frequency bandwidth of 0 to 500 Hz. We recommend the Navy conduct passive acoustic monitoring, using current SURTASS receiver system or additional towed system, with expanded frequency bandwidth (i.e., broader than 0 to 500 Hz, and if feasible up to 100 kHz) to increase the dectectability of all ESA-listed marine mammal species that may occur in the action area.
7. We recommend the Navy consider using the potential standards for towed array passive acoustic monitoring in the *Towed Array Passive Acoustic Operations for Bioacoustic Applications: ASA/JNCC Workshop Summary March 14-18, 2016 Scripps Institution of Oceanography, La Jolla, California, USA* (Thode 2017).

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

11 REINITIATION OF CONSULTATION

This concludes formal consultation for the U.S. Navy's proposed use of SURTASS LFA sonar routine training, testing, and military operations. As 50 CFR §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 incidental take is exceeded; (2) new information reveals effects of the agency action that may affect ESA-listed species or designated critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the ESA-listed species or designated critical habitat that was not considered in this opinion, or (4) a new species is ESA-listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the Navy must contact the NMFS ESA Interagency Cooperation Division, Office of Protected Resources immediately.

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