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Executive Order 12114
and
National Environmental
Policy Act Section 102(2)(C)

Executive Summary
Final Supplemental
Environmental Impact Statement
for
Surveillance Towed Array Sensor System
Low Frequency Active (SURTASS LFA) Sonar

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Abstract

This Supplemental Environmental Impact Statement (SEIS) evaluates the potential environmental impacts of employing the Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar. It has been prepared by the Department of the Navy in accordance with the requirements of Presidential Executive Order (EO) 12114 (Environmental Effects Abroad of Major Federal Actions) and the National Environmental Policy Act of 1969 (NEPA). The Navy currently plans to operate up to four SURTASS LFA sonar systems. At present the Research Vessel (R/V) *Cory Chouest* and the USNS IMPECCABLE (T-AGOS 23) are the only vessels equipped with SURTASS LFA sonar. The additional SURTASS LFA sonar systems would be installed on the USNS VICTORIOUS (T-AGOS 19) Class ocean surveillance vessels. In addition to the No Action Alternative, the SEIS analyzed four additional alternatives. The analysis of these five alternatives is intended to address NEPA deficiencies identified in the Ninth District Court's 26 August 2003 opinion, as well as to fulfill the Navy's responsibilities under NEPA with regard to providing additional information related to the proposed action. The SEIS considers mitigation measures, including coastal standoff restrictions of 22 and 46 km (12 and 25 nm) and the designation of additional offshore biologically important areas.

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EXECUTIVE SUMMARY

This Supplemental Environmental Impact Statement (SEIS) evaluates the potential environmental effects of employment of Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar systems. The proposed action herein is the U.S. Navy's employment of up to four SURTASS LFA sonar systems in the oceanic areas as presented in Figure 1-1 of the Final Overseas Environmental Impact Statement/Environmental Impact Statement (FOEIS/EIS) for SURTASS LFA Sonar and shown as Figure ES-1 below. Based on current operational requirements, exercises using these sonar systems would occur in the Pacific, Atlantic, and Indian oceans, and the Mediterranean Sea. To reduce adverse effects on the marine environment, areas would be excluded as necessary to prevent 180-decibel (dB) sound pressure level (SPL) or greater within specified geographic range of land, in offshore biologically important areas during biologically important seasons, and in areas necessary to prevent greater than 145-dB SPL at known recreational and commercial dive sites.

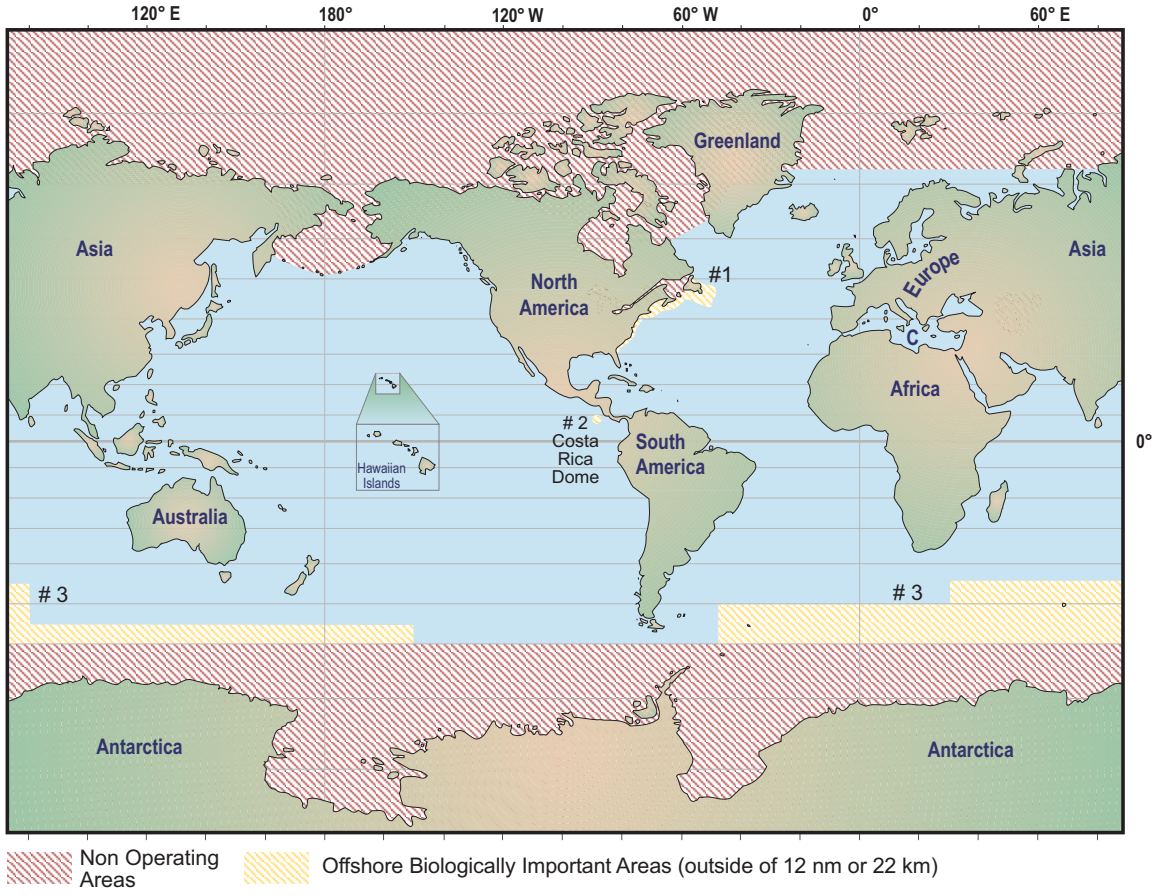

Figure ES-1. SURTASS LFA Sonar Potential Areas of Operations

The purpose of the SURTASS LFA Sonar SEIS is to:

- Address concerns of the U.S. District Court for the Northern District of California in its 26 August 2003 Opinion and Order in relation to compliance with the National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Marine Mammal Protection Act (MMPA)[1];
- Provide information necessary to apply for a new five-year Rule that would provide for incidental takes under the MMPA when the current rule expires in 2007, taking into account legislative changes to the MMPA and the need to employ up to four SURTASS LFA sonar systems;
- Analyze potential impacts for LFA system upgrades; and
- Provide additional information and analyses pertinent to the proposed action.

References to Underwater Sound Levels

1. References to underwater sound pressure level (SPL) in this SEIS are values given in decibels (dBs), and are assumed to be standardized at 1 microPascal at 1 m (dB re 1 µPa at 1 m [rms]) for Source Level (SL) and dB re 1 µPa (rms) for Received Level (RL), unless otherwise stated.
2. References to underwater Sound Exposure Level (SEL) in this SEIS refer to the squared pressure over a duration of the sound referenced to the standard underwater sound reference level (1 µPa) expressed in dB, and are assumed to be standardized at dB re 1 μPa^2-s, unless otherwise stated.

Sources: Urick (1983); ANSI S1.8-1989

In response to U.S. District Court ruling on the motion for preliminary injunction, the Deputy Assistant Secretary of the Navy for Environment (DASN(E)) decided that the purposes of NEPA would be served by supplemental analysis of employing SURTASS LFA sonar systems. On 11 April 2003, the DASN(E) directed the Navy to prepare a supplemental environmental impact statement (EIS) to address concerns identified by the Court, to provide additional information regarding the environment that could potentially be affected by the SURTASS LFA sonar systems, and to provide additional information related to mitigation (See APPENDIX A).

The FOEIS/EIS for SURTASS LFA sonar was completed in January 2001 by the Department of the Navy (DON) with the National Marine Fisheries Service (NMFS) as a cooperating agency in accordance with the requirements of NEPA[2] and Presidential Executive Order (EO) 12114 (Environmental Effects Abroad of Major Federal Actions)[3]. The DASN(E) signed the Record of

[1] On 2 December 2004, the Court vacated and dismissed the MMPA claims based on the National Defense Authorization Act Fiscal Year 2004 (NDAA FY04) amendments to the MMPA.

[2] The provisions of NEPA apply to major federal actions that occur or have effects in the United States, its territories, and possessions.

[3] The provisions of EO 12114 apply to major federal actions that occur or have effects outside of U.S. territories (the United States, its territories, and possessions).

Decision (ROD) on 16 July 2002 (*Federal Register* (FR) (67 FR 48145)), authorizing the operational employment of SURTASS LFA sonar systems contingent upon issuance by NMFS of letters of authorization (LOAs) under the MMPA and incidental take statements (ITSs) under ESA for each vessel.

In order to improve military readiness, the Department of Defense (DoD) asked Congress to amend several provisions of environmental laws as they applied to military training and testing activities. These legislative amendments were provided by Congress as parts of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2003 (Public Law 107-314) and the NDAA for FY 2004 (Public Law 108-136).

The term "military readiness activity" is defined in NDAA for FY 2003 (16 U.S.C. § 703 note) to include all training and operations of the Armed Forces that relate to combat; and the adequate and realistic testing of military equipment, vehicles, weapons and sensors for proper operation and suitability for combat use. NMFS and the Navy have determined that the Navy's SURTASS LFA sonar testing and training operations that are the subject of NMFS's July 16, 2002, Final Rule constitute a military readiness activity because those activities constitute "training and operations of the Armed Forces that relate to combat" and constitute "adequate and realistic testing of military equipment, vehicles, weapons and sensors for proper operation and suitability for combat use."

The provisions of this act that specifically relate to SURTASS LFA concern revisions to the MMPA, as summarized below:

- Overall – Changed the MMPA definition of "harassment," adjusted the permitting system to better accommodate military readiness activities, and added a national defense exemption.
- Amended definition of "harassment" as it applies to military readiness activities and scientific activities conducted on behalf of the Federal government.
- Level A "harassment" defined as any act that injures or has the *significant* potential to injure a marine mammal or marine mammal stock in the wild.
- Level B "harassment" 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 the patterns are abandoned or significantly altered*.
- Secretary of Defense may invoke a national defense exemption not to exceed two years for DoD activities after conferring with the Secretary of Commerce and the Secretary of Interior, as appropriate[4].
- NMFS's determination of "least practicable adverse impact on species or stock" must include consideration of personnel safety, practicality of implementation, and impact on the effectiveness of the military readiness activity.
- Eliminated the "small numbers" and "specified geographic region" requirements from the incidental take permitting process for military readiness activities.

[4] On 31 June 2006 and 23 June 2007, the Deputy Secretary of Defense invoked the national defense exemption under the MMPA for certain mid-frequency sonar activities. Neither of these national defense exemptions apply to SURTASS LFA sonar employment as detailed in this SEIS.

The SEIS focuses on:

- DASN(E) direction to:
  - Provide additional information regarding the environment that could potentially be affected by employment of SURTASS LFA;
  - Provide additional information related to mitigation of the potential impacts of the system;
- Addressing pertinent deficiencies raised by the Court including:
  - Additional mitigation and monitoring;
  - Additional area alternatives analysis;
  - Analysis of the potential impacts of LF sound on fish;
- Providing the information necessary to apply for a new five-year rule that would provide for incidental takes under the MMPA, taking into account the NDAA FY04 amendments to the MMPA for military readiness.

Additional SEIS analyses include:

- Updating literature reviews and determination of data gaps, especially for fish, sea turtles, and marine mammals;
- Marine animal LF sound thresholds/impacts based on Fish Controlled Exposure Experiments (CEE) and updated literature reviews;
- LF sound impact analysis to include:
  - Geographic areas;
  - Marine mammal impacts under NDAA FY04 definition of "harassment;"
  - Fish impacts;
  - Other listed species' impacts, as required;
- Mitigation (need for mitigation will be determined by impact analysis based on new legislation).

The information in the SURTASS LFA sonar FOEIS/EIS remains valid, except as noted or modified in the SEIS. The contents of the FOEIS/EIS are incorporated into the SEIS by reference, except as noted or modified.

ES.1 Purpose and Need

The original stated purpose for SURTASS LFA sonar systems from the FOEIS/EIS was:

> "The purpose of the proposed action is to meet U.S. need for improved capability to detect quieter and harder-to-find foreign submarines at long range. This capability would provide U.S. forces with adequate time to react to, and defend against, potential submarine threats while remaining a safe distance beyond a submarine's effective weapons range."

This statement remains valid, and may be more compelling now than when it was presented in the FOEIS/EIS in January 2001. With the Cold War ending more than a decade ago, the Navy is

now faced with a large number of diesel-electric submarines with operations confined to a smaller littoral area rather than the open ocean nuclear submarine fleet[5]. Maritime strategies rely heavily on quiet submarines to patrol the littorals, blockade strategic choke points, and stalk aircraft carrier battle groups[6].

To meet its long-range detection need, the Navy investigated the use of a broad spectrum of acoustic and non-acoustic technologies to enhance antisubmarine warfare (ASW) capabilities. Of those technologies evaluated, low frequency active sonar remains the only system capable of providing long-range detection during most weather conditions, day or night. Low frequency active sonar is, therefore, the only available technology capable of meeting the U.S. need to improve detection of quieter and harder-to-find foreign submarines at long range. SURTASS LFA sonar is providing a quantifiable improvement in the Navy's capabilities against this threat and markedly improves the survivability of U.S Naval forces in a hostile ASW scenario.

ES.2 Description of Proposed Action and Alternatives

SURTASS LFA sonar systems are long-range systems operating in the LF band (below 1,000 Hertz [Hz]) within the frequency range of 100 to 500 Hz. These systems are composed of both active and passive components as shown in Figure ES-2.

SONAR is an acronym for SOund NAvigation and Ranging, and its definition includes any system that uses underwater sound, or acoustics, for observations and communications. Sonar systems are used for many purposes, ranging from "fish finders" to military ASW systems for detection and classification of submarines. There are two broad types of sonar:

- Passive sonar detects the sound created by an object (source) in the water. This is a one-way transmission of sound waves traveling through the water from the source to the receiver and is basically the same as people hearing sounds that are created by another source and transmitted through the air to the ear.
- Active sonar detects objects by creating a sound pulse or "ping" that is transmitted through the water and reflects off the target, returning in the form of an echo. This is a two-way transmission (source to reflector to receiver). Some marine mammals locate prey and navigate utilizing this form of echolocation.

[5] Friedman, N. 2004. The New Challenge—and a New Solution. Sea Technology, 45:11 p. 7.

[6] Goldstein, L., and B. Murray. 2003. China's Subs Lead the Way. Proceedings, U.S.Nav.Inst., Vol 129/3/1,202 pp.58-61.

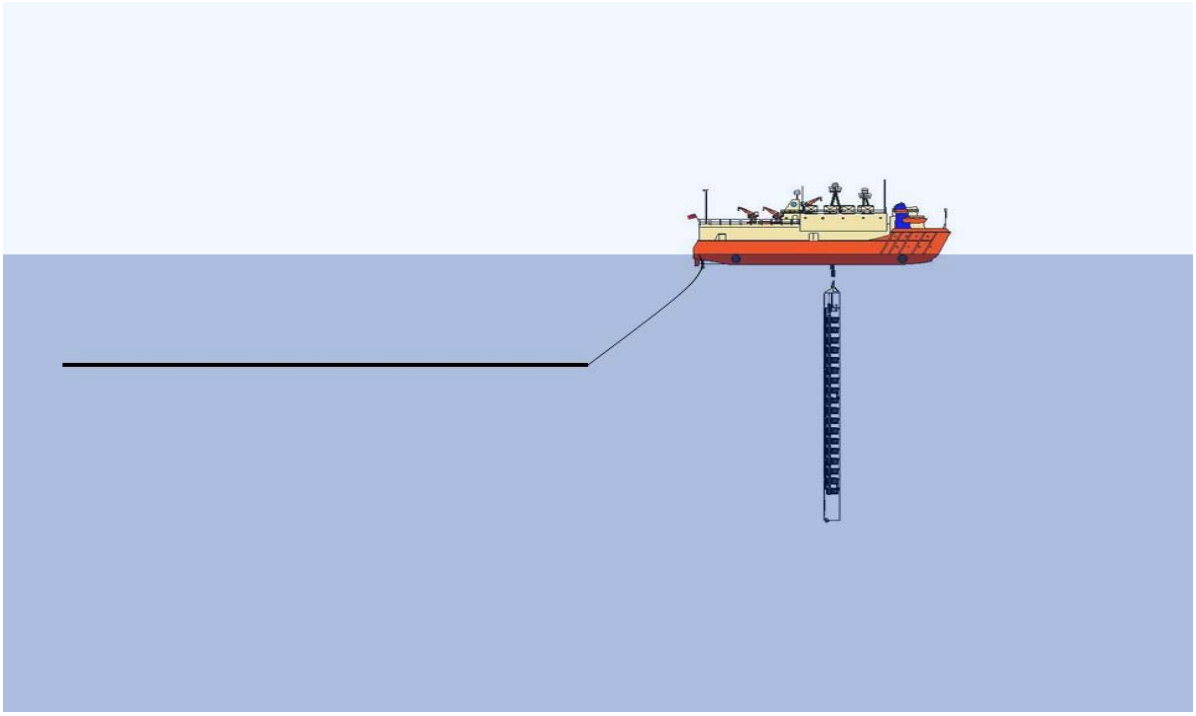

Figure ES-2. SURTASS LFA sonar systems.

ES.2.1 Proposed Action

The proposed action herein is the U.S. Navy employment of up to four SURTASS LFA sonar systems in the oceanic areas as presented in the FOEIS/EIS for SURTASS LFA Sonar and Figure ES-1. Based on current operational requirements, exercises using these sonar systems would occur in the Pacific, Atlantic, and Indian oceans, and the Mediterranean Sea.

As future undersea warfare requirements continue to transition to littoral ocean regions, the development and introduction of a compact active system deployable from existing, smaller SURTASS SWATH-P ships is paramount. This system upgrade is known as Compact LFA, or CLFA. CLFA consists of smaller, lighter-weight source elements than the current LFA system, and will be compact enough to be installed on the existing SURTASS platforms, VICTORIOUS (T-AGOS 19) Class. The operational characteristics of the compact system are comparable to the existing LFA systems as presented in Subchapter 2.1 of the FOEIS/EIS and the SEIS. Therefore, the potential impacts from CLFA are expected to be similar to, and no greater than, the effects from the existing SURTASS LFA sonar systems. Hence, for this analysis, the term low frequency active, or LFA, will be used to refer to both the existing LFA system and/or the compact (CLFA) system, unless otherwise specified.

At present, there are two existing SURTASS LFA sonar systems—one each onboard the Research Vessel (R/V) *Cory Chouest* and USNS IMPECCABLE (T-AGOS 23). Three additional CLFA systems are planned for the T-AGOS 19 Class. With the R/V *Cory Chouest* retiring in Fiscal Year (FY) 2008, only two or three systems will be operational through FY 2010. Early in

FY 2011 the potential exists for four vessels to be operational. At no point are there expected to be more than four systems in use.

The active component of the system, LFA, is a set of LF acoustic transmitting source elements (called projectors) suspended by cable from underneath a ship. These projectors produce the active sonar signal or "ping." A "ping" or transmission can last between 6 and 100 seconds. The time between transmissions is typically from 6 to 15 minutes. The average duty cycle (ratio of sound "on" time to total time) is between 10 and 20 percent. The typical duty cycle based on historical LFA operations from 2003 to 2006 is nominally 7.5 to 10 percent (DON, 2007)[7]. The SURTASS LFA sonar signal is not a continuous tone, but rather a transmission of various waveforms that vary in frequency and duration. The duration of each continuous frequency sound transmission is never longer than 10 seconds. The signals are loud at the source, but levels diminish rapidly over the first kilometer.

The passive, or listening, component of the system is SURTASS, which detects returning echoes from submerged objects, such as threat submarines, through the use of hydrophones on a receiving array that is towed behind the ship. The SURTASS LFA ship maintains a speed of 5.6 kilometers (km) per hour (kph) (3 knots [kt]) through the water to tow the horizontal line hydrophone array.

ES.2.2 Alternatives

NEPA requires federal agencies to prepare an EIS that discusses the environmental effects of a reasonable range of alternatives (including the No Action Alternative). The FOEIS/EIS initially analyzed all potential technologies, both acoustic and non-acoustic, and determined that only active sonar (specifically LFA) would meet the purpose and need. The FOEIS/EIS then analyzed the No Action Alternative and two additional alternatives. The District Court's 26 August 2003 opinion found that the Navy did not fulfill its responsibilities under NEPA with regard to the alternatives analyses. To address the Court's findings, the SEIS analyzed the No Action Alternative and four additional alternatives. The analyses of these five alternatives are intended to address, among other things, mitigation measures including coastal standoff restrictions of 22 and 46 km (12 and 25 nautical miles [nm]), seasonal restrictions, the designation of additional offshore biologically important areas (OBIAs), and shutdown procedures for schools of fish. The five alternatives considered in the SEIS are as follows:

- No Action Alternative;
- Alternative 1—Same as the FOEIS/EIS Preferred Alternative;
- Alternative 2 (Preferred Alternative)—Alternative 1 with additional OBIAs;
- Alternative 3—Alternative 1 with extended coastal standoff distance to 46 km (25 nm); and
- Alternative 4—Alternative 1 with additional OBIAs, extended coastal standoff distance to 46 km (25 nm), and shutdown procedures for schools of fish.

[7] Department of the Navy (DON). 2007. Final Comprehensive Report for the Operation of the Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Onboard the R/V *Cory Chouest* and USNS IMPECCABLE (T-AGOS 23) Under the National Marine Fisheries Service Regulations 50 CFR 216 Subpart Q. January 2007

ES.3 Affected Environment

The areas of the marine environment that have the potential to either affect, or be affected by, SURTASS LFA sonar employment are:

- Marine Environment, including ambient noise in the oceans, physical environmental factors affecting acoustic propagation, ocean acoustic regimes, and oceanographic features affecting marine mammal distribution;
- Marine Organisms, including fish, sea turtles, and marine mammals; and
- Socioeconomic Conditions, including commercial and recreational fishing, other recreational activities, and research and exploration activities.

ES.3.1 Marine Environment

There have been no significant changes to the knowledge or understanding in the marine environment, acoustic propagation, or propagation modeling. The information in Subchapter 3.1 (Marine Environment) in the FOEIS/EIS remains valid, and its contents are incorporated by reference herein to the SEIS.

In a recent analysis for the Policy on Sound and Marine Mammals: An International Workshop sponsored by the U.S. Marine Mammal Commission (MMC) and the Joint Nature Conservation Committee (UK) in 2004, Dr. John Hildebrand provided a comparison of anthropogenic underwater sound sources by their annual energy output. The actual percentage of the total anthropogenic acoustic energy budget added by each LFA source is estimated to be 0.5 percent per system (or less), when compared to other man-made sources (Hildebrand, 2004)[8]. When combined with the naturally occurring and other man-made sources of noise in the oceans, LFA barely contributes a measurable portion of the total acoustic energy. This and LFA's low duty cycle (nominally 7.5 to 10 percent during the projected 432 hours of operations per vessel per year) support the conclusion that the operation of up to four SURTASS LFA systems will not be expected to significantly add to oceanic ambient noise.

ES.3.2 Scientific Screening of Marine Animal Species for Potential Sensitivity to LF Sound

In order for marine species to be affected by the operation of the SURTASS LFA sonar, they must: 1) occur within the same ocean region and during the same time of year as the SURTASS LFA sonar operation, 2) possess some sensory mechanism that allows it to perceive the LF sounds, and/or 3) possess tissue with sufficient acoustic impedance mismatch to be affected by LF sounds.

[8] Hildebrand, John. 2004. Sources of Anthropogenic Sound in the Marine Environment. Report to the Policy on Sound and Marine Mammals: An International Workshop. U.S. Marine Mammal Commission and Joint Nature Conservation Committee, UK. London, England.

This selection rationale was presented in the FOEIS/EIS and is updated in the SEIS. The selection started with virtually all marine animal species, including both invertebrates and vertebrates. Based on the above criteria, this list was distilled down to five groups of vertebrates, including sharks and rays, bony fish, sea turtles, whales and dolphins, and seals and sea lions. Virtually all invertebrates were eliminated from further consideration because: 1) they do not have delicate organs or tissues whose acoustic impedance is significantly different from water, and 2) there is no evidence of auditory capability in the frequency range used by SURTASS LFA sonar.

ES.3.3 Marine Organisms

A thorough review of available literature of fish, sea turtles, and marine mammals was conducted with emphasis on data developed after the completion of the FOEIS/EIS in 2001. These data are detailed in the SEIS, Subchapter 3.2.

ES.3.4 Socioeconomic

A thorough review of available literature of commercial and recreational fisheries, recreational activities, and research and exploration activities was conducted with emphasis on data developed after the completion of the FOEIS/EIS in 2001. These data are detailed in the SEIS, Subchapter 3.3.

ES.4 SEIS Analytical Process

The SEIS analyses and results of the potential impacts or effects upon various components of the environment that could result from the implementation of the proposed action and of alternatives to the proposed action are consistent with the SURTASS LFA sonar FOEIS/EIS. They have been updated based on the best available literature, the Long Term Monitoring Program of current SURTASS LFA sonar operations, and continuing research. Further, there are no new data that contradict any of the assumptions or conclusions regarding Chapter 4 in the FOEIS/EIS; hence its contents are incorporated by reference herein to the SEIS.

This section will provide summaries of the recent research and update the analysis of the potential effects of the alternatives based on the following SURTASS LFA sonar operational parameters:

- Small number of SURTASS LFA sonar systems to be deployed (maximum of four);
- Geographic restrictions imposed on system employment;
- Narrow bandwidth of SURTASS LFA sonar active signal (approximately 30 Hz);
- Slowly moving ship (5.6 kph [3 knots]), coupled with low system duty cycle means marine animals spend less time in the LFA mitigation zone (180-dB sound field); further, with both the vessel and the animal moving, the potential for animals being in the sonar transmit beam during the nominal 7.5 to 10 percent of the time (projected 432 hours per vessel per year) the sonar is actually transmitting is very low; and
- Small size of the LFA mitigation zone (180-dB sound field) relative to open ocean areas.

The types of potential effects on marine animals from SURTASS LFA sonar operations can be broken down into several categories:

- **Non-auditory injury**: This includes the potential for resonance of the lungs/organs, tissue damage, and mortality. For the purposes of the SURTASS LFA sonar analyses presented in this SEIS, all marine animals exposed to $\geq$ 180 dB Received Level (RL) are evaluated as if they are injured.
- **Permanent threshold shift (PTS)**: A severe situation occurs when sound intensity is very high or of such long duration that the result is PTS or permanent hearing loss on the part of the listener.
- **Temporary threshold shift (TTS)**: Sounds of sufficient loudness can cause a temporary condition in which an animal's hearing is impaired for a period of time (TTS). After termination of the sound, normal hearing ability returns over a period that may range anywhere from minutes to days, depending on many factors, including the intensity and duration of exposure to the intense sound.
- **Behavioral change**: Various vertebrate species are affected by the presence of intense sounds in their environment. For military readiness activities, like use of SURTASS LFA sonar, Level B "harassment" under the MMPA is defined as any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns to a point where the patterns are abandoned or significantly altered. Behaviors include migration, surfacing, nursing, breeding, feeding, and sheltering. While sea turtles and fish do not fall under harassment definitions, like marine mammals, it is possible that loud sounds could disturb the behavior of fish and sea turtles in the same way, resulting in the same kinds of consequences as for marine mammals.
- **Masking**: The presence of intense sounds in the environment can potentially interfere with an animal's ability to hear sounds of relevance to it. This effect, known as "auditory masking," could interfere with the animal's ability to detect biologically relevant sounds, such as those produced by predators or prey, thus increasing the likelihood of the animal not finding food or being preyed upon.

ES.4.1 Potential Impacts on Fish

The Court found the FOEIS/EIS lacking because the Navy failed to adequately consider potential impacts to fish. In order to determine the effects of SURTASS LFA sonar on fish, the Navy sponsored independent research with the University of Maryland to examine whether exposure to high-intensity, low frequency sonar, such as the Navy's SURTASS LFA sonar, would affect fish. This study examined the effect of LFA on hearing, the structure of the ear, and select non-auditory systems in the rainbow trout (*Onchorynchus mykiss*) and channel catfish (*Ictalurus punctatus*) and included observations of fish behavior before, during, and after sound exposure.

Since the SURTASS LFA sonar FOEIS/EIS was completed in 2001, there have been a small number of useful studies on the potential effects of underwater sound on fish, including sharks. However, the University of Maryland study (funded by the Navy to provide data for this SEIS) is directly relevant to potential effects of SURTASS LFA sonar on fish. Thus, while earlier studies examined the effects of sounds using pure tones for much longer duration than the SURTASS

LFA sonar signals, this study provides insight into the impact of LF sounds on fish. With the caveat that so far only two species have been examined in this study, the investigations found little or no effect of high intensity sounds, and there was no mortality as a result of sound exposure, even when fish were maintained for days post-exposure.

The Fish CEE concentrated on the fish species with the potential to be most effected by LFA—listed salmonid from the order *Salmoniformes*. Because the rainbow trout (a hearing generalist) is of the same toxemic genus, they have similar, if not identical, ears and hearing sensitivity, they can be used as "reference species" to determine the potential effects on other salmonid and, more generally, on other hearing generalist. Channel catfish were selected for the CEE to be reference species for hearing specialist. Thus, one must examine select species and use them as "reference species." From the perspective of the University of Maryland studies, the rainbow trout and the channel catfish are excellent reference species for fish that do not hear well (trout) and those that do hear well (Catfish).

Results of SURTASS LFA sonar study

As of 30 June 2005, there have been four sets of studies (each lasting one week) on rainbow trout and two on channel catfish (Popper et al., 2005[9]; Halvorsen et al., 2006[10]). There are several significant findings.

- No fish died as a result of exposure to the experimental source signals.
- Despite the high level of sound exposure (193 dB RL at the fish), there were no gross pathological effects on fish. Histopathology was done on all major body tissues (brain, swim bladder, heart, liver, gonads, blood, etc.) and no differences were found among sound-exposed fish, controls, or baseline animals.
- There were no short- or long-term effects on ear tissue. The sensory cells of the ears of both species were healthy and intact both immediately post-exposure and then 96 hours after the end of exposure.
- Fish behavior after sound exposure was no different than behavior prior to the tests.
- Catfish and some specimens of rainbow trout showed 10-20 dB of hearing loss immediately after exposure to the LFA sound when compared to baseline and control animals, but hearing appeared to return to, or close to, normal within about 24 hours for catfish. Other rainbow trout showed minimal or no hearing loss.

Conclusions from SURTASS LFA sonar study

The critical question addressed in the SURTASS LFA sonar study was whether this type of sound source would impair the survival of fish and, more importantly, whether survival would be impaired in a typical environment when a ship using SURTASS LFA sonar was in the vicinity of a fish. Several factors were taken into consideration.

[9] Popper, A.N., M.B. Halvorsen, D. Miller, M.E. Smith, J. Song, L.E. Wysocki, M.C. Hastings, A.S. Kane, and P.Stein. 2005a. Effects of surveillance towed array sensor system (SURTASS) low frequency active sonar on fish. J. Acoust. Soc. Am. 117, 2440 (2005).

[10] Halvorsen, M. B., Wysocki, L. E., and Popper, A. N. 2006. Effects of high-intensity sonar on fish. J. Acoust. Soc. Am. 119:3283.

First, the sound level to which fish were exposed in these experiments was 193 dB RL, a level that is only found within about 200 m (656 ft) of the SURTASS LFA source array. Thus, the likelihood of exposure to this or a higher sound level is extremely small. The volume of the ocean ensonified by a single SURTASS LFA sonar source at 193 dB RL or higher is very small compared to fish or fish school ocean habitats.

Second, the LFA sound used in the study can be considered to represent a "worst-case" exposure. In effect, the exposures during the experiments were most likely substantially greater than any exposure a fish might encounter in the wild. In the study described here, each fish received three 108-second exposures to high-level LFA sound. However, under normal circumstances the SURTASS LFA sonar source is on a moving ship. A fish in one location can only receive maximum ensonification for a very few seconds (depending on ship speed and whether the fish is moving or not, and its direction of motion and speed). Before the SURTASS LFA vessel gets close to the fish, or after the ship has moved on, the sound level at the fish would be much lower. Since exposure at maximum levels did not cause damage to fish, and only what appears to be a temporary limited hearing loss, it is unlikely that a shorter exposure would result in any measurable hearing loss or non-auditory damage to fish. While it was not possible to present a higher sound level to the fish in this experiment, it is very likely that a shorter exposure than 108 seconds to an even higher sound level may not have adversely affected the fish.

To quantify the possible effect of SURTASS LFA sonar on fisheries catches, an analysis of nominal SURTASS LFA sonar operations in a region off the Pacific Coast of the U.S. was presented in the FOEIS/EIS Subchapter 4.3.1 for the NMFS Fisheries Resource Region—Pacific Coast, defined here to encompass the area from the Canadian to Mexican border, from the shoreline out to 926 km (500 nm). The results of this analysis–that the percent of fisheries catch potentially affected would be negligible compared to fish harvested commercially and recreationally in the region–remain valid. In fact, because this analysis was based on 180-dB injury level (1000 vice 200 m) and a 20 percent (20 vice 7.5 percent) duty cycle, the results are *highly conservative.*

ES.4.2 Potential Impacts on Sea Turtle Stocks

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 than the SURTASS LFA sonar signals. The SEIS provides summaries of recent research and updates to the analysis of the potential effects of the alternatives based on the SURTASS LFA sonar operational parameters.

Sea turtles could be affected if they are inside the LFA mitigation zone (180-dB sound field) during a SURTASS LFA sonar transmission. The SEIS updates the FOEIS/EIS analysis, focusing on the potential impacts to individual sea turtles and the issue of potential impact to sea turtle stocks. To quantify the potential impact on sea turtle stocks, the analysis provided in the FOEIS/EIS was updated based on more current information for leatherback sea turtles in the Pacific Ocean. Leatherbacks were chosen for this analysis because they are the largest, most pelagic, and most widely distributed of any sea turtle found between 71 degrees N and 47

degrees S latitude, inhabit the oceanic zone, and are capable of transoceanic migrations. They are rarely found in coastal waters and are deep, nearly continuous divers with usual dive depths around 250 m (820 ft). Based on a conservative estimate of 20,000 leatherback sea turtles for the Pacific basin, the possible number of times a leatherback could be within the 180-dB sound field of a SURTASS LFA sonar vessel during transmissions was estimated to be less than 0.2 animals per year per vessel. Therefore, the potential for SURTASS LFA sonar operations to impact leatherback sea turtle stocks is negligible, even when up to four systems are considered.

In the unlikely event that SURTASS LFA sonar operations coincide with a sea turtle "hot spot," the following factors mitigate any potential impact on the animals to a negligible level: 1) the narrow bandwidth of the SURTASS LFA sonar active signal (approximately 30 Hz bandwidth); 2) the ship is always moving (coupled with low system duty cycle [nominal 7.5 to 10 percent], which means sea turtles would have less opportunity to be located in the LFA mitigation zone during a transmission); 3) the sea turtle is often moving; and 4) the monitoring mitigation incorporated into the alternatives (visual and active acoustic [HF] monitoring).

ES.4.3 Potential Impacts on Marine Mammal Stocks

The types of potential effects on marine mammals from SURTASS LFA sonar operations can be broken down into non-auditory injury (such as tissue damage and acoustically mediated bubble growth), permanent loss of hearing, temporary loss of hearing, behavioral change, and masking. The analyses of these potential impacts were presented in the SURTASS LFA sonar FOEIS/EIS. Updated literature reviews and research results indicate that there are no new data that contradict any of the assumptions or conclusions in the FOEIS/EIS; thus, its findings regarding potential impacts on marine mammals remain valid and are incorporated by reference to the SEIS.

The potential effects from SURTASS LFA sonar operations on any stock of marine mammals from injury (non-auditory or permanent loss of hearing) are considered negligible, and the potential effects on the stock of any marine mammal from temporary loss of hearing or behavioral change (significant change in a biologically important behavior) are considered minimal. Any auditory masking in marine mammals due to SURTASS LFA sonar signal transmissions is not expected to be severe and would be temporary.

ES.4.4 Risk Assessment Approach for SURTASS LFA Sonar Operations

The FOEIS/EIS provided detailed risk assessments of potential impacts to marine mammals covering the major ocean regions of the world: North and South Pacific Oceans, Indian Ocean, North and South Atlantic Oceans, and the Mediterranean Sea. The 31 acoustic modeling sites in the FOEIS/EIS represented the upper bound of impacts (both in terms of possible acoustic propagation conditions, and in terms of marine mammal population and density) that could be expected from operation of the SURTASS LFA sonar system. The conservative assumptions of the FOEIS/EIS are still valid. Moreover, there are no new data that contradict any of the assumptions or conclusions made in the FOEIS/EIS. Thus, it is not necessary to reanalyze the potential acoustic impacts in the SEIS.

Under the MMPA Rule, the Navy must apply for annual LOAs. In these applications, the Navy projects where it intends to operate for the period of the next annual LOAs and provides NMFS with reasonable and realistic risk estimates for marine mammal stocks in the proposed areas of operation. The LOA application analytical process utilizes a conservative approach by integrating mission planning needs and a cautious assessment of the limited data available on specific marine mammal populations, seasonal habitat and activity. Because of the incorporation of conservative assumptions, it is likely that the aggregate effect of such assumptions is an overestimation of risk—a prudent approach for environmental conservation when there are data gaps and other sources of uncertainty. The total annual risk for each stock of marine mammal species is estimated by summing a particular species' risk estimates within that stock, across mission areas. Each stock, for a given species, is then examined. Based on this approach, the highest total annual estimated risk (upper bound) for marine mammal species' stocks are provided in the applications for LOAs.

Information on how the density and stock/abundance estimates are derived for the selected mission sites is provided in the LOA applications. These data are derived from current, available published source documentation, and provide general area information for each mission area with species-specific information on the animals that could potentially occur in that area, including estimates for their stock/abundance and density.

ES.4.4.1 Interim Operational Restrictions and Proposed Modifications to Mitigation

The SEIS evaluates the interim operational restrictions imposed by NMFS during the regulatory process under the initial MMPA Rule and LOAs, as issued, and questions raised by the Court concerning mitigation.

NMFS interim operational restrictions

In the SURTASS LFA Sonar Final Rule under the MMPA (67 FR 46785), NMFS added interim operational restrictions, including the establishment of a 1-km (0.54-nm) buffer shutdown zone outside of the 180-dB LFA mitigation zone and limiting the operational frequency of SURTASS LFA sonar to 330 Hz and below.

1-km buffer zone

The 1-km (0.54 nm) buffer zone interim operational restriction has proven to be practical under the current operations, but the analysis in the SEIS demonstrates that it did not perceptibly minimize adverse impacts below 180-dB RL. The differences in the number of animals affected were insignificant. Thus, the removal of this interim operational restriction would not appreciably change the percentage of animals potentially affected.

330-Hz restriction

The LFA rule-making process under the MMPA commenced in 1999 and ended when the LFA Rule was promulgated in July 2002. During this period, the potential for LFA, and sonar in general, to cause resonance-related injury in marine mammals above 330 Hz was an open issue.

NMFS, therefore, added an interim operational restriction to the LFA Rule and associated LOAs limiting LFA operations to 100 to 330 Hz vice 100 to 500 Hz as originally stated in the FOEIS/EIS. For the SURTASS LFA sonar systems installed onboard the R/V *Cory Chouest* and USNS IMPECCABLE, this interim restriction was feasible. However, the frequency requirements for the Compact LFA (CLFA) to be installed onboard the smaller VICTORIOUS Class (T-AGOS 19 Class) vessels are somewhat higher, but still within the original 100 to 500 Hz range.

In November 2002, NMFS provided its "Report of the Workshop on Acoustic Resonance as a Source of Tissue Trauma in Cetaceans" (DOC, 2002)[11]. The report concluded that the tissue-lined air spaces most susceptible to resonance are too large in marine mammals to have resonance frequencies in the range used by either mid or low frequency sonar. In 2004 the Marine Mammal Commission sponsored a workshop on understanding the impacts of anthropogenic sound on beaked whales (Cox et al., 2006)[12].The MMC workshop results stated that acoustic resonance is highly unlikely in the lungs of beaked whales, but did recommend further studies to fully eliminate this hypothesized mechanism (Cox et al., 2006). Cudahy and Ellison (2002)[13] stated that each of their *in vivo* and theoretical studies relating to tissue damage from underwater sound support a damage threshold on the order of 180 to 190 dB.

Since the FOEIS/EIS was published in early 2001, research has been published in a peer-reviewed journal that supports the 180-dB criterion for injury. Laurer et al. (2002)[14] from the Department of Neurosurgery, University of Pennsylvania School of Medicine, exposed Sprague-Dawley rats to 5 minutes of continuous high intensity, low frequency (underwater) sound (HI-LFS) either at 180 dB SPL re 1 µPa at 150 Hz or 194 dB SPL re 1 µPa at 250 Hz, and found no overt histological damage in brains of any group. Also blood gases, heart rate, and main arterial blood pressure were not significantly influenced by HI-LFS, suggesting that there was no pulmonary dysfunction due to prolonged exposures at 180 dB and 194 dB. This published paper was based on work performed in support of Technical Report #3 of the SURTASS LFA Sonar FOEIS/EIS.

[11]Department of Commerce (DOC). 2002. Report on the workshop on acoustic resonance as a source of tissue trauma in cetaceans. April 24 and 25, 2002. Silver Spring, Maryland. National Marine Fisheries Service, Silver Spring, Maryland.

[12] Cox, T.M., T.J. Ragen, A.J. Read, E. Vox, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernandez, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, Y. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D.C Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, and L. Benner. 2006. Understanding the impacts of anthropogenic sound on beaked whales. J. Cetacean Res. Manage. 7(3):177-187.

[13] Cudahy, E. and W.T. Ellison. 2002. A review of the potential for *in vivo* tissue damage by exposure to underwater sound, report for the Department of the Navy. Department of the Navy, Washington, D.C

[14] Laurer, H.L., A.N. Ritting, A.B. Russ, F.M. Bareyre, R. Raghupathi, and K.E. Saatman. 2002. Effects of underwater sound exposure on neurological function and brain histology. Ultrasound in Med. &. Biol., Vol. 28, No. 7, pp. 965-973.

Finally, the Ocean Studies Board of the National Research Council (NRC) in its report on Marine Mammal Populations and Ocean Noise stated that resonance from air spaces is not likely to lead to detrimental physiological effects on marine mammals (NRC, 2005)[15].

Analyses sponsored by the Navy (Cudahy and Ellison, 2002; Laurer et al., 2002), reports on two workshops on acoustic impacts (DOC, 2002; Cox, et al., 2006), and the NRC Ocean Studies Board (NRC, 2005) support the conclusion that resonance from LFA operations is not a reasonably foreseeable impact, providing the empirical and documentary evidence that resonance and/or tissue damage from LFA transmissions are unlikely to occur in marine mammals in the frequency range 330 to 500 Hz within or outside the LFA mitigation zone. As a result, the Navy has requested NMFS to rescind this interim operational restriction in the new rule making.

Court's issues

The Court found the FOEIS/EIS lacking because the Navy: 1) should have considered training in areas that present a reduced risk of harm to marine life and the marine environment when practicable; 2) should have further considered extending the shutdown procedures beyond marine mammals and sea turtles to schools of fish; 3) failed to adequately consider potential impacts to fish; and 4) raised the question concerning the inclusion of requirements for additional monitoring and mitigation through the use of aircraft or small observational craft prior to operating close to shore.

Training in areas of reduced risk

The identification of a SURTASS LFA sonar operating area that is particularly devoid of marine life is not straightforward. The reason that certain areas are believed to have minimal marine mammal activity could very well be because of gaps in animal distribution, abundance and density data there. It usually is more feasible to identify areas of high marine life concentrations and avoid them when practicable. This sensitivity/risk process is the methodology applied to SURTASS LFA sonar operations.

The process starts with the Navy's antisubmarine warfare (ASW) requirements to be met by SURTASS LFA sonar based on mission areas proposed by the Chief of Naval Operations (CNO) and fleet commands. Thereupon, available published data are collected, collated, reduced and analyzed with respect to marine mammal populations and stocks, marine mammal habitat and seasonal activities, and marine mammal behavioral activities. Utilizing the best available scientific data, estimates are made by highly-qualified marine biologists, based on known data for like species and/or geographic areas, and known marine mammal seasonal activity. If marine mammal densities prove to be high and/or sensitive animal activities are expected, the mission areas are changed and/or refined and the process is re-initiated for the modified area. Next, standard acoustic modeling and risk analysis are performed, taking into account spatial, temporal or operational restrictions. Then, standard mitigation is applied and risk estimates for marine mammal stocks in the proposed mission area are calculated. Based on these estimates, a decision

[15] National Research Council (NRC). 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. National Academy Press. Washington, D.C.

is made as to whether the proposed mission area meets the conditions on MMPA regulations and LO)As, as issued, on marine mammal/animal impacts from SURTASS LFA sonar. If not, the proposed mission area is changed or refined, and the process is re-initiated. If the mission area risk estimates are below the required restrictions, it is considered that the Navy has identified and selected the potential mission area with minimal marine mammal/animal activity consistent with its operational readiness requirements and restrictions placed on LFA operations by NMFS in the regulatory and consultation processes.

Potential injury to fish

The Court found the FOEIS/EIS lacking because the Navy failed to adequately consider potential impacts to fish. Independent research was sponsored by the Navy to address this issue (as discussed above). With the caveat that only a few species have been examined in these studies, the investigations found little or no effect of high intensity sounds (193 dB RL) on a number of taxonomically[16] and morphologically[17] diverse species of fish, and there was no mortality as a result of sound exposure, even when fish were maintained for days post-exposure.

Modification of shutdown procedures for schools of fish

Modifying the current SURTASS LFA sonar shutdown protocols to include schools of fish must be weighed against the feasibility and practicality of such a mitigation procedure in the context of military readiness and training. First, based on recent field experimentation, for a fish to suffer injury, it must be extremely close (within 200 m [656 ft]) to the source array during transmission (nominally transmitting 7.5 to 10 percent of the time). The SURTASS LFA vessel travels at an average speed of 5.6 kph (3 knots) and fish travel at nominal speeds of 5.6 kph (3 knots) (e.g., herring, pike, carp) up to maximum speeds of 74 to 93 kph (40 to 50 knots) (e.g., tuna, swordfish). Thus, the opportunity for a fish or a school of fish to be exposed to sound pressure levels from SURTASS LFA transmissions that could cause harm must be considered to be negligible. Moreover, the implementation of fish mitigation procedures is impractical. Visual monitoring (daylight only) cannot be relied upon to detect fish schools, passive acoustic detection is infeasible, and active acoustics would give so many false alarms that the impact on the effectiveness of the military readiness activity (and, hence impact on National Security) would be high. Therefore, mitigation protocols for fish are first and foremost not required because the potential for effects is negligible based on scientific research. Furthermore, these protocols are infeasible and impractical when applied to military readiness and training activities.

Pre-operational surveys

In order to determine if pre-operational aerial or small boat surveys are feasible and necessary mitigation measures according to the MMPA's treatment of such considerations in a military readiness context, the SEIS evaluated the feasibility of these surveys based on the following factors: 1) weather conditions, 2) time of day, 3) availability of small boats or small aircraft, 4) proximity to hostile territory, 5) sea state, 6) logistics, 7) overall safety considerations, and 8)

[16] Taxonomically means to be based on formal classification of organisms into phylum, order, family, genus, or species.
[17] Morphologically means to be based on the structure and form of living organisms.

National Security. The findings were that small boat and pre-operational aerial surveys for SURTASS LFA operations are not feasible because they are not practicable, not effective, may increase the harassment of marine mammals, and are not safe to the human performers.

In its comments on the Draft SEIS, the Marine Mammal Commission concurred that carrying out small boat or aerial surveys immediately before and during SURTASS LFA sonar operations in the various offshore training areas would not be a practical mitigation option.

ES.4.4.2 Marine Mammal Strandings

Marine mammal strandings are not a rare occurrence. The Cetacean Stranding Database (www.strandings.net) registers that over a hundred strandings occurred worldwide in the year 2004. However, mass strandings, particularly multi-species mass strandings, are relatively rare. Many theories exist as to why noise may be a factor in marine mammal strandings. Several recent stranding events that have been publicly reported and which may, or may not, have been attributed to anthropogenic sound, are discussed in the SEIS.

There are different types of anthropogenic sounds potentially associated with possible impacts to and strandings of marine mammals. Accounts of many of these stranding events are associated with military sonars. A wide range of military sonars are used to detect, localize and classify underwater targets. For the purposes of the SURTASS LFA SEIS analysis, these systems are categorized as low frequency active (LFA) (< 1000 Hz) and mid frequency active (MFA) (1 to 10 kHz). Differences in operational parameters dictate that the potential for LFA and MFA to affect marine mammals is not the same.

Cox et al. (2006) provided a summary of common features shared by the strandings events in Greece (1996), Bahamas (2000), and Canary Islands (2002). These included deep water close to land (such as offshore canyons), presence of an acoustic waveguide (surface duct conditions), and periodic sequences of transient pulses (i.e., rapid onset and decay times) generated at depths less than 10 m (32.8 ft) by sound sources moving at speeds of 2.6 m/s (5.1 knots) or more during sonar operations (D'Spain et al., 2006)[18]. Several of these features do not relate to LFA operations. First, the SURTASS LFA vessel operates with a horizontal line array (SURTASS: a passive listening system) of 1,500 m (4,921 ft) length at depths below 150 m (492 ft) and a vertical line array (LFA sonar source) at depths greater than 100 m. Second, operations are limited by mitigation protocols to at least 22 km (12 nm) offshore. For these reasons SURTASS LFA sonar cannot be operated in deep water that is close to land. Also the LFA signal is transmitted at depths well below 10 m (32.8 ft), and the vessel has a slow speed of advance of 1.5 m/s (3 knots).

While it is true that there was a LF component of the sonar in use at the time of the Greek stranding in 1996, only mid-frequency components were present in the strandings in the Bahamas in 2000, Madeira 2000, and Canaries in 2002. This supports the logical conclusion that

[18] D'Spain, G.L., A. D'Amico, and D.A. Fromm. 2006. Properties of the underwater sound fields during some well documented beaked whale mass stranding events. J. Cetacean Res. Manage. 7:223-23.

the LF component in the Greek stranding was not causative (ICES, 2005[19]; Cox et al., 2006). In its discussion of the Bahamas stranding, Cox et al. (2006) stated, "The event raised the question of whether the mid-frequency component of the sonar in Greece in 1996 was implicated in the stranding, rather than the low-frequency component proposed by Frantzis (1998)[20]." The International Council for the Exploration of the Sea (ICES) in its "Report of the Ad-Hoc Group on the Impacts of Sonar on Cetaceans and Fish" raised the same issue as Cox et al., stating that the consistent association of MF sonar in the Bahamas, Madeira, and Canary Islands strandings suggest that it was the MF component, not the LF component, in the NATO sonar that triggered the Greek stranding of 1996 (ICES, 2005).

Most odontocetes have relatively sharply deceasing hearing sensitivity below 2 kHz. If a cetacean cannot hear a sound of a particular frequency or hears it poorly, then it is unlikely to have a significant behavioral impact (Ketten, 2001)[21]. Therefore, it is unlikely that LF transmissions from LFA would induce behavioral reactions from animals that have poor LF hearing; e.g., beaked whales, bottlenose dolphins, striped dolphins, harbor porpoise, belugas, and orcas (summarized in: Nedwell et al., 2004).[22]

The ICES (2005) report concluded that no strandings, injury, or major behavioral change has yet to be associated with the exclusive use of LF sonar.

The important point here is that there is no record of SURTASS LFA sonar ever being implicated in any stranding event since LFA prototype systems were first operated in the late 1980s. The logical conclusion that LFA sonar is not related to marine mammal strandings is supported by the 2004 Workshop on Understanding the Impacts of Anthropogenic Sound on Beaked Whales convened by the Marine Mammal Commission (Cox et al., 2006) and the ICES Ad-Hoc Group on the Impacts of Sonar on Cetaceans and Fish (AGISC) (ICES, 2005).

ES.4.5 Socioeconomics

This SEIS addresses the potential impact to commercial and recreational fisheries, other recreational activities, and research and exploration activities, that could result from implementation of the alternatives under consideration.

Commercial and recreational fisheries

SURTASS LFA sonar operations are geographically restricted such that LFA received levels are less than 180 dB RL at least 22 km (12 nm) from coastlines and at the boundaries of offshore biologically important areas during biologically important seasons, where fisheries productivity is generally high. In addition, the results from the LFA controlled exposure studies by the

[19] International Council for the Exploration of the Sea (ICES). 2005. Ad-Hoc Group on the Impact of Sonar on Cetaceans. ICES AGISC 2005. Copenhagen, Denmark.

[20] Frantzis, A. 1998. Does acoustic testing strand whales? Nature 392:29.

[21] Ketten, D. 2001. Congressional Testimony House Resources Committee, Subcommittee on Fisheries Conservation, Wildlife and Oceans Hearing: Marine Mammal Protection Act/Low Frequency Sonar. October 11, 2001.

[22] Nedwell, J.R., B. Edwards, A.W.H. Turnpenny, and J. Gordon. 2004. Fish and Marine Mammal Audiograms: A Summery of Available Information. September 3, 2004.

University of Maryland provide evidence that SURTASS LFA sonar sounds at relatively high levels (up to 193 dB RL) have minimal impact on the reference species of fish studied (rainbow trout and channel catfish). Therefore, the University of Maryland data support the conclusion that SURTASS LFA will have no or minimal effects on commercial or recreational fishing (Popper et al., 2005; Halvorsen et al., 2006).

Other recreational activities

There are no new data that contradict any of the assumptions or conclusions in the FOEIS/EIS regarding swimming, snorkeling, diving, and whale watching.

Research and exploration activities

It is not believed that SURTASS LFA sonar operations will affect research submersibles, nor seafloor cable-laying. Oceanographic research activities and oil and gas exploration could potentially be affected, as they use equipment such as air guns, hydrophones, and ocean-bottom seismometers. If in the vicinity of a research or exploration activity, SURTASS LFA sonar could possibly interfere with or saturate the hydrophones of these other operations. Research activities and oil and gas exploration, though, could also potentially interfere with SURTASS LFA sonar operations. For these reasons, SURTASS LFA sonar operations are not expected to be close enough to these activities to significantly affect them to any measurable degree.

ES.4.6 Potential Cumulative Impacts

Three areas are evaluated to compare the incremental impacts of SURTASS LFA sonar operations with past, present, and reasonably foreseeable future actions. These include:

- Comparison to anthropogenic oceanic noise levels;
- Comparison of injury and lethal takes from anthropogenic causes; and
- Synergistic effects.

The potential cumulative impact issue associated with SURTASS LFA sonar operations is the addition of underwater sound to oceanic ambient noise levels, which in turn could have impacts on marine animals through the potential to cause masking and stress. Masking has the potential to increase marine animals' susceptibility to other impacts, such as bycatch and ship strikes. Anthropogenic sources of ambient noise that are most likely to have contributed to increases in ambient noise levels are commercial shipping, offshore oil and gas exploration and drilling, and naval and other use of sonar (ICES, 2005).

In a recent analysis for the Policy on Sound and Marine Mammals: An International Workshop sponsored by the Marine Mammal Commission (U.S.) and the Joint Nature Conservation Committee (UK) in 2004, Dr. John Hildebrand provided a comparison of anthropogenic underwater sound sources by their annual energy output. The actual percentage of the total anthropogenic acoustic energy budget added by each LFA source is estimated to be 0.5 percent per system (or less), when other man-made sources are considered (Hildebrand, 2004). When combined with the naturally occurring and other man-made sources of noise in the oceans, LFA

barely contributes a measurable portion of the total acoustic energy. This and the LFA low duty cycle (nominally 7.5 to 10 percent) support the conclusion that the operation of up to four SURTASS LFA systems will not be expected to significantly add to oceanic ambient noise.

Because LFA transmissions are intermittent and will not significantly increase anthropogenic oceanic noise, cumulative impacts and synergistic effects from the proposed four SURTASS LFA sonar systems for masking and stress are not a reasonable foreseeable significant adverse impact on marine animals. Therefore, cumulative impacts and synergistic effects that would lead to injury or lethal takes of marine animals from masking including bycatch and ship strikes are not a reasonable foreseeable significant adverse impact on marine animals from exposure to LFA.

In view of the fact that there are major differences in signal characteristics between LFA, MFA, and seismic air guns, there is negligible chance of producing a "synergistic" sound field. It is also unlikely that LFA sources, if operated in proximity to each other would produce a sound field so complex that marine animals would not be able to escape.

In the analysis of the potential for socioeconomic impacts to commercial and recreational fisheries, other recreational activities, and research and exploration activities, it was concluded that there would be no substantial effects from implementation of the alternatives under consideration. Therefore, socioeconomic cumulative impacts and synergistic effects are not reasonably foreseeable.

Given the information provided in this subchapter, the potential for cumulative impacts and synergistic effects from the operations of up to four SURTASS LFA sonars is considered to be small and has been addressed by limitations proposed for employment of the system (i.e., geographical restrictions and monitoring mitigation). Even if considered in combination with other underwater sounds, such as commercial shipping, other operational, research, and exploration activities (e.g., acoustic thermometry, hydrocarbon exploration and production), recreational water activities, and naturally-occurring sounds (e.g., storms, lightning strikes, subsea earthquakes, underwater volcanoes, whale vocalizations, etc.), the SURTASS LFA sonar systems do not add appreciably to the underwater sounds to which fish, sea turtle and marine mammal stocks are exposed. Moreover, SURTASS LFA sonar will cause no lethal takes of marine mammals.

Therefore, cumulative impacts and synergistic effects of the operation of up to four SURTASS LFA sonar systems are not reasonably foreseeable.

ES.4.7 Evaluation of Alternatives

NEPA requires federal agencies to prepare an EIS that discusses the environmental effects of a reasonable range of alternatives (including the No Action Alternative). Reasonable alternatives are those that will accomplish the purpose and meet the need of the proposed action, and those that are practical and feasible from a technical and economic standpoint.

The SEIS provides an analysis of the proposed alternatives for the employment of SURTASS LFA sonar. In addition to the No Action Alternative, four alternatives were analyzed to satisfy the Court's findings and to determine the potential effects of changes to the proposed action. These alternatives include:

- No Action Alternative
- Alternative 1—Same as the FOEIS/EIS Alternative 1 with 22 km (12 nm) coastal standoff distance and the original four OBIAs as presented in the FOEIS/EIS and the LOAs, as issued.;
- Alternative 2—Alternative 1 with additional OBIAs;
- Alternative 3—Alternative 1 with extended coastal standoff distance to 46 km (25 nm); and
- Alternative 4—Alternative 1 with additional OBIAs, extended coastal standoff distance to 46 km (25 nm), and shutdown procedures for fish schools.

ES.4.7.1 Analysis of Alternatives

The SEIS analyses these alternatives, including additional OBIAs (Table ES-1), shutdown procedures for fish schools, and increasing the coastal standoff from 22 to 46 km (12 to 25 nm).

Table ES-1. Offshore Biologically Important Areas

Area Number	Name of Area	Location of Area	Months of Importance
1	200 m isobath of North American East Coast[1]	From 28°N to 50°N west of 40°W	Year Round
2	Costa Rica Dome	Centered at 9°N and 88°W	Year Round
3	Antarctic Convergence Zone	30°E to 80°E: 45°S. 80°E to 150°E: 55°S 150°E to 50°W: 60°S 50°W to 30°E: 50°S	October through March
4	Hawaiian Island Humpback Whale NMS—Penguin Bank[2]	Centered at 21°N and 157° 30''W	November 1 through May 1
5	Cordell Bank NMS[2]	Boundaries IAW 15 CFR 922.110	Year Round
6	Gulf of the Farallones NMS[2]	Boundaries IAW 15 CFR 922.80	Year Round
7	Monterey Bay NMS[2]	Boundaries IAW 15 CFR 922.130	Year Round
8	Olympic Coast NMS[2]	Within 23 nm of coast from 47°07'N to 48°30'N latitude	December, January, March and May
9	Flower Garden Banks (NMS)[2]	Boundaries IAW 15 CFR 922.120	Year Round

Note: 1. OBIA boundaries encompass Northern Right Whale Critical Habitat, Stellwagen Bank NMS, Monitor NMS, and Gray's Reef NMS.
2. Office of National Marine Sanctuaries, National Ocean Service, NOAA, letter dated 15 May 2001.

Offshore biologically important areas (OBIAs)

The Navy has addressed the Court-defined deficiency regarding additional OBIAs in its preferred alternative, Alternative 2. The additional OBIAs are shown in Table ES-1 (Area numbers 4 through 9), and reflect a thorough review of potential areas where SURTASS LFA sonar may be restricted from operating without significantly impacting the Navy's required ASW readiness and training evolutions.

Shutdown procedures for schools of fish

Recent scientific results from fish controlled exposure experiments (CEEs) with LFA signals indicate that the opportunity for a fish or a school of fish to be exposed to sound pressure levels from SURTASS LFA sonar transmissions that could cause harm is negligible. Therefore, mitigation protocols for fish are not required because the potential for effects is negligible based on scientific research. Furthermore, these protocols are infeasible and impractical when applied to military readiness and training activities.

Generic analytical methodology for coastal standoff range comparison

Analyses in the FOEIS/EIS and this SEIS support the argument that the highest potential for impact from SURTASS LFA sonar operations would be to marine mammals. Hence, a generic analytical methodology was applied to determine the difference in potential impact to marine animals (including fish, sharks, and sea turtles, but particularly for marine mammals) between a 22 km (12 nm) and a 46 km (25 nm) coastal standoff for SURTASS LFA sonar operations. A six-step process was followed for this analysis. Based on the analysis of the risk areas and potential impacts to marine mammals, increasing the coastal standoff range does decrease exposure to higher received levels for concentrations of marine animals closest to shore (shelf species); but does so at the expense of increasing exposure levels for shelf break and pelagic species.

It is important to note that the results of this analysis—that overall there is a greater risk of potential impacts to marine animals with the increase of the coastal standoff distance from 22 km (12 nm) to 46 km (25 nm)—may at first appear counter-intuitive. This greater risk is due to an increase in affected area, with less of the ensonified zone of influence overlapping land for the 46 km (25 nm) standoff distance than for the 22 km (12 nm) standoff distance. Essentially, by locating the array in waters further from land, nominally the same animal density regions are typically ensonified, but more water area is affected.

ES.5 Mitigation and Monitoring

Alternative 2 (the Navy's preferred alternative) incorporates mitigation measures into operation of the SURTASS LFA sonar. The objective of these mitigation measures is to avoid injury to marine mammals and sea turtles near the SURTASS LFA sonar source and to recreational and commercial divers in the coastal environment.

This objective would be met by Navy adherence to the following restrictions on SURTASS LFA sonar operations:

- SURTASS LFA sonar-generated sound field would be below 180 dB (RL) within 22 km (12 nm) of any coastlines and in offshore areas outside this zone that have been determined by NMFS and the Navy to be biologically important (see Table ES-1 for the inclusion of additional Offshore Biologically Important Areas);
- When in the vicinity of known recreational or commercial dive sites, SURTASS LFA sonar would be operated such that the sound fields at those sites would not exceed 145 dB (RL); and
- SURTASS LFA sonar operators would estimate SPLs prior to and during operations to provide the information necessary to modify operations, including the delay or suspension of transmissions, in order not to exceed the 180-dB and 145-dB sound field criteria.

In addition, the following monitoring to prevent injury to marine animals would be required when employing SURTASS LFA sonar:

- Visual monitoring for marine mammals and sea turtles from the vessel during daylight hours by personnel trained to detect and identify marine mammals and sea turtles;
- Passive acoustic monitoring using the low frequency SURTASS array to listen for sounds generated by marine mammals as an indicator of their presence; and
- Active acoustic monitoring using the High Frequency Marine Mammal Monitoring (HF/M3) sonar, which the Navy developed, enhanced high frequency (HF) commercial sonar, to detect, locate, and track marine mammals, and to some extent sea turtles, that may pass close enough to the SURTASS LFA sonar's transmit array to enter the 180-dB sound field (LFA mitigation zone). The HF/M3 sonar will provide for detection of marine animals 24 hours a day and during periods of reduced visibility.

ES.7 Conclusion

The following conclusions are supported by the analyses addressing the operations of up to four SURTASS LFA sonar systems in the FOEIS/EIS, which are incorporated by reference herein; and the supplementary analyses undertaken in this SEIS, which also encompass the at-sea operations of up to four systems.

No Action Alternative

In summary, the No Action Alternative would avoid all environmental effects of employment of SURTASS LFA sonar. It does not, however, support the Navy's stated priority ASW need for long-range underwater threat detection. The implementation of this alternative would allow potentially hostile submarines to clandestinely threaten U.S. Fleet units and land-based targets. Without this long-range surveillance capability, the reaction times to enemy submarines would be greatly reduced and the effectiveness of close-in, tactical systems to neutralize threats would be seriously, if not fatally, compromised.

Alternative 1

Under Alternative 1, as was concluded in the FOEIS/EIS, the potential impact on any stock of marine mammals from injury is considered to be negligible, and the effect on the stock of any marine mammal from significant change in a biologically important behavior is considered to be minimal. Any momentary behavioral responses and possible indirect impacts to marine mammals due to potential impacts on prey species are considered not to be biologically significant effects. Any auditory masking in mysticetes, odontocetes, or pinnipeds is not expected to be severe and would be temporary. Further, the potential impact on any stock of fish, sharks or sea turtles from injury is also considered to be negligible, and the effect on the stock of any fish, sharks or sea turtles from significant change in a biologically important behavior is considered to be negligible to minimal. Any auditory masking in fish, sharks or sea turtles is expected to be of minimal significance and, if occurring, would be temporary.

Alternative 2 (the preferred alternative)

Under Alternative 2, additional geographical restrictions would be levied on SURTASS LFA sonar operations through the inclusion of more offshore biologically important areas (OBIAs). The general summary provided in the above paragraph for Alternative 1 would also apply to this alternative.

Alternative 3

Under Alternative 3, additional geographical restrictions would be levied on SURTASS LFA sonar operations through the increase in the coastal standoff range from 22 km (12 nm) to 46 km (25 nm). The general summary provided in the above paragraph for Alternative 1 would also apply to this alternative. Based on the analysis of the risk areas and the potential impacts to marine animals, increasing the coastal standoff range does decrease exposure to higher received levels for the concentrations of marine animals closest to shore; but does so at the expense of increasing exposure levels for shelf break species and pelagic species.

Alternative 4

Under Alternative 4, the additional geographical restrictions of both Alternative 2 (additional OBIAs) and Alternative 3 (increase in coastal standoff range from 22 km [12 nm] to 46 km [25 nm]), plus shutdown procedures for schools of fish would be combined. The general summary provided for Alternative 1 above also applies here, as do the results from Alternative 2 regarding additional OBIAs and Alternative 3 regarding the increased standoff range.

Recent scientific results from fish controlled exposure experiments (CEEs) with LFA signals indicate that the opportunity for a fish or a school of fish to be exposed to sound pressure levels from SURTASS LFA sonar transmissions that could cause harm is negligible. Therefore, mitigation protocols for fish are not necessary because the potential for effects is negligible based on scientific research. Furthermore, these protocols are infeasible and impractical when applied to military readiness and training activities.

Results Summary

Table ES-2 provides a qualitative estimate of the ability of each alternative to meet the Navy's purpose and need. Alternative 2 (additional OBIAs) would be expected to decrease to some extent the littoral areas where SURTASS LFA sonar could operate outside of 22 km (12 nm); thus the detection of threats in the littorals and training in the littorals would remain high but may be slightly degraded compared to Alternative 1. Alternatives 3 and 4, the expansion of the coastal standoff range from 22 km (12 nm) to 46 km (25 nm), and the expansion of the coastal standoff range plus the additional OBIAs would be expected to impose the greatest impact on meeting the Navy's purpose and need, and military readiness, as a much larger portion of the littorals would be restricted from the conduct of SURTASS LFA sonar operations.

Given the results from the alternatives analysis presented above and Table ES-2, the Navy's preferred alternative is Alternative 2.

Table ES-2. Estimate of ability to meet the Navy's Purpose and Need/Military Readiness/Training for Alternatives 1 through 4.

	Detection of threats in open ocean	Detection of threats in littorals	Training in open ocean	Training in littorals
No Action Alternative	N/A	N/A	N/A	N/A
Alternative 1	H	H	H	H
Alternative 2	H	H	H	H
Alternative 3	H	M/H	H	M/H
Alternative 4	H	M/H	H	M/H

N/A = Does not meet/not applicable
L = Low level
M = Medium level
H = High level

ES.8 Public Participation

The public participation program for the SURTASS LFA Sonar SEIS began with publication of a Notice of Intent (NOI) to prepare a supplemental analysis in the *Federal Register* on July 28, 2003 (68 FR 44311).

Commencing in early November 2005, copies of the Draft SEIS were distributed to agencies and officials of federal and state governments, citizen groups and associations, and other interested parties. A Notice of Availability (NOA) was published in the *Federal Register* (70 FR 68443). The Draft SEIS was made available for review at 17 public libraries located in many coastal states including Hawaii. A copy of the Draft SEIS was also available on the SURTASS LFA Sonar OEIS/EIS Internet website (http://www.surtass-lfa-eis.com).

During the 90-day public comment period on the Draft SEIS, public hearings were conducted in Washington, DC; San Diego, California; and Honolulu, Hawaii. Notifications for the public

hearings were published in the *Federal Register* and in local newspapers. The hearings were conducted in accordance with NEPA requirements and comments became part of the record.

During the comment period, which ended on February 10, 2006, the Navy received comments from 97 government agencies, organizations, and individuals. No petitions were submitted. In addition, no statements were presented at the December 1, 2005, public hearing in Washington, DC; 3 statements were presented at the December 3, 2005, public hearing in San Diego, CA; and 11 statements were presented at the December 5, 2005, public hearing in Honolulu, HI.

All comments received were categorized into broad issues based on the organization of the SEIS. These issues were further subdivided into more specific comments/questions. Responses to these comments/questions were then drafted and reviewed for scientific and technical accuracy and completeness. The Navy's responses also identify cases in which a specific comment generated a revision to the Draft SEIS (denoted by underlined text), or when the existing text of the Final SEIS is deemed an adequate response to a comment, the appropriate chapter, subchapter, and/or appendix is identified.

Comment submissions, written hearing transcripts and statements have been included in Volume 2 to the SEIS.

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