FINAL COMPREHENSIVE REPORT FOR THE OPERATION OF SURVEILLANCE TOWED ARRAY SENSOR SYSTEM LOW FREQUENCY ACTIVE (SURTASS LFA) SONAR 2012 TO 2016

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL OPERATIONS
DECEMBER 2016

FINAL COMPREHENSIVE REPORT FOR THE OPERATION OF SURVEILLANCE TOWED ARRAY SENSOR SYSTEM LOW FREQUENCY ACTIVE (SURTASS LFA) SONAR—2012 TO 2016 ONBOARD USNS VICTORIOUS, USNS ABLE, USNS EFFECTIVE, AND USNS IMPECCABLE

UNDER THE NATIONAL MARINE FISHERIES SERVICE REGULATIONS 50 CFR 216 SUBPART Q

DECEMBER 2016

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
µPa	microPascal(s)
%	percent or percentage
AIP	Air-independent propulsion
ANSI	American National Standards Institute
APB	advanced processor build
ASW	Anti-Submarine Warfare
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CLFA	Compact Low Frequency Active
CNO	Chief of Naval Operations (U.S.)
CW	continuous wave
dB	decibel(s)
dB re 1 µPa	decibels referenced to one microPascal
dB re 1 µPa @ 1 m	decibels referenced to one microPascal measured at one meter from center of acoustic source
dB re 1 μPa^2-sec	decibels of the time integral (summation) of the squared pressure of a sound event
DI	directivity index (of sonar array)
DoD	U.S. Department of Defense
DoN	U.S. Department of the Navy
DSEIS/SOEIS	Draft SEIS/SOEIS
DT	detection threshold (of sonar array)
EIS	Environmental Impact Statement
EO	Executive Order (Presidential)
EOG	Executive Oversight Group
ESA	Endangered Species Act
FCR	Final Comprehensive Report

Acronym	Definition
FEIS	Final Environmental Impact Statement
FM	frequency modulated
FOEIS/EIS	Final Overseas Environmental Impact Statement/EIS
FR	Federal Register
FSEIS	Final Supplemental Environmental Impact Statement
ft	feet/foot
HF	high frequency
HF/M3	high frequency/marine mammal monitoring
HLA	horizontal line array
hr	hour(s)
Hz	Hertz
ICP	Integrated Common Processor
IUSS	Integrated Undersea Surveillance System
km	kilometer(s)
kph	kilometers per hour
kt	knot(s)
LF	low frequency
LFA	Low Frequency Active
LOA	Letter of Authorization
m	meter(s)
M3	marine mammal monitoring
MILCREW	military crew
min	minute(s)
MMPA	Marine Mammal Protection Act
Navy	U.S. Department of the Navy
NL	noise level
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
nmi	nautical mile(s)

Acronym	Definition
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
OBIA	offshore biologically important area
OEIS	Overseas Environmental Impact Statement
OIC	Officer in Charge
Pa	Pascal
PTAS	passive towed array sensor
SEL	sound exposure level
RL	received level
rms	root mean square
ROD	Record of Decision
SAG	Scientific Advisory Group
sec	second(s)
SEIS	Supplemental Environmental Impact Statement
SEL	sound exposure level
SHARK	Submarine Hold at Risk
SL	source level
SOEIS	Supplemental Overseas Environmental Impact Statement
sonar	sound navigation and ranging
SPE	single ping equivalent
SPL	sound pressure level
SURTASS	Surveillance Towed Array Sensor System
T-AGOS	Tactical-Auxiliary General Ocean Surveillance
TRAP	Transformational Reliable Acoustic Path
U.S.	United States

1 INTRODUCTION

Under the National Marine Fisheries Service (NMFS) Final Rule regulations under the Marine Mammal Protection Act (MMPA) for the taking of marine mammals incidental to Navy operation of Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA[1]) sonar (NOAA, 2012), the Navy is required to provide NMFS and the public with a final comprehensive report (FCR) that contains a status summary of the reporting and monitoring requirements of the final year (2016 to 2017) Letters of Authorization (LOAs) (NOAA, 2016) and an unclassified analysis of new passive sonar technologies and an assessment of whether these technologies are feasible alternatives to SURTASS LFA sonar. Additionally, this report provides a summary of the annual reports for SURTASS LFA sonar operations from August 2012 to date.

1.1 PURPOSE

The primary purpose of this FCR is to provide NMFS with a summary of SURTASS LFA sonar operations onboard the United States Navy Ship (USNS) VICTORIOUS (Tactical-Auxiliary General Ocean Surveillance [T-AGOS] 19) USNS ABLE (T-AGOS 20) (Figure 1-1), USNS EFFECTIVE (T-AGOS 21), and USNS IMPECCABLE (T-AGOS 23) over the last four-plus years and an update on passive sonar technologies that together demonstrate conformance to the terms and conditions of the 2012 Final Rule and annual LOAs under the MMPA as well as the Biological Opinions and incidental take statements (ITS) authorized under the Endangered Species Act (ESA). This report includes a summary of the mitigation, monitoring, and reporting conducted during the period of the 2012 Final MMPA Rule for SURTASS LFA sonar, an estimate of cumulative impacts on marine mammal stocks based on best scientific judgment, and an analysis of the advancement of alternative passive acoustic technologies and the feasibility of any new passive sonar systems as a replacement for LFA sonar.

1.2 SURTASS LFA SONAR SYSTEM

SURTASS LFA sonar is a long-range system operating in the low-frequency (LF) band (below 1,000 hertz [Hz]). This system is composed of both active and passive components. The active component is the LFA sonar source array and the passive component is the SURTASS receive array. The SURTASS LFA sonar system uses two basic types of sonar:

- Passive sonar detects the sound created by an object (source) in water. This is a one-way transmission of sound waves through the water from the source to the receiver and is the same as people hearing sounds that are created by a source and transmitted through the air to the ear. Very simply, passive sonar "listens" without sending any sound signals.
- Active sonar detects objects by creating a sound pulse, or "ping," that is transmitted through the water and reflects off a target, returning in the form of an echo to be detected by a receiver. Active sonar is a two-way transmission (source to reflector to receiver). Some marine mammals use a type of active biosonar called echolocation to locate underwater objects such as prey for feeding or the seafloor for navigation.

1 The terms "SURTASS LFA sonar" or "SURTASS LFA sonar systems" are inclusive of both the LFA and Compact LFA (CLFA) sonar systems, each having similar acoustic operating characteristics.

Figure 1-1. Ocean Surveillance Ship USNS ABLE (T-AGOS 20).

1.2.1 Active Sonar System Component

The active component of the SURTASS LFA sonar system, LFA, is an adjunct to the SURTASS passive capability and is employed when active sound signals are needed to detect and track underwater targets. 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.

LFA sonar consists of a vertical source array of transmitting elements suspended by cable under one of the T-AGOS vessels (Figure 1-1). These elements, called projectors, are devices that produce the active sonar sound pulses, or pings. To produce a ping, the projectors transform electrical energy to mechanical energy (i.e., vibrations), which travel as pressure disturbances in water. The LFA sonar source is a vertical line array (VLA) consisting of as many as 18 source projectors. Each LFA source projector transmits sonar beams that are omnidirectional (360 degrees) in the horizontal, with a narrow vertical beamwidth that can be steered above or below the horizontal. The source frequency ranges between 100 and 500 Hertz (Hz).

1.2.2 Passive Sonar System Components

SURTASS is the passive, or listening, component of the system that detects returning echoes from submerged objects, such as threat submarines, through the use of hydrophones. Hydrophones transform mechanical energy (received acoustic sound waves) to an electrical signal that can be analyzed by the processing system of the sonar. SURTASS consists of a twin-line (TL-29A) horizontal line array (HLA), which is a “Y” shaped array with two apertures that is approximately 1,000 feet (ft) (305 meters [m]) long. The TL-29A can be towed in shallow, littoral environments; provides significant

directional noise rejection; and resolves bearing ambiguities without having to change the vessel's course.

To tow the HLA, a SURTASS LFA sonar vessel typically maintains a speed of at least 3 knots (kt) (5.6 kilometers per hour [kph]). The return (received) signals, which are usually below background or ambient noise level, are processed and evaluated to identify and classify potential underwater threats.

1.2.3 Operating Profile

The operating features of the active component, LFA sonar, are:

- The source level (SL) of an individual source projector on the LFA sonar array is approximately 215 decibels referenced to one microPascal measured at one meter from center of acoustic source (dB re 1 µPa at 1 m) root mean squared (rms) or less. Since the projectors work together as an array to create the sound field, the array's measured sound field will never be higher than the SL of an individual source projector.
- The typical LFA sonar signal is not a constant tone but consists of various waveforms that vary in frequency and duration. A complete sequence of sound transmissions (waveforms) is referred to as a wavetrain (also known as a ping). These wavetrains last between 6 and 100 seconds, with an average length of 60 seconds. Within each wavetrain, a variety of signal types can be used, including continuous wave (CW) and frequency-modulated (FM) signals. The duration of each continuous-frequency sound transmission within the wavetrain is no longer than 10 seconds.
- Average duty cycle (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 to 2016), is nominally 7.5 to 10 percent.
- The time between wavetrain transmissions is typically from 6 to 15 minutes.

The SURTASS LFA sonar vessels usually operate independently but may operate in conjunction with other naval air, surface, or submarine assets. The T-AGOS vessels generally travel in straight lines or racetrack patterns depending on the operational scenario.

1.3 Operational Requirements

The employment of up to four SURTASS LFA sonar systems is authorized with geographical restrictions that include maintaining LFA sonar RLs below 180 dB re 1 µPa (rms) within 12 nautical miles (nmi) (22 kilometers [km]) of any land and within 0.54 nmi (1 km) of the boundary of designated offshore biologically important areas (OBIAs) for SURTASS LFA sonar during their respective effective periods of significant biological activity. Additionally, the sound fields generated by SURTASS LFA sonar will not exceed RLs of 145 dB re 1 µPa (rms) within known recreational and commercial dive sites. The Navy does not operate LFA sonar in polar regions of the world. Due to the uncertainties in the world's political climate, future operating locations and conditions cannot be predicted. In its annual application for LOAs, the Navy specifies the ocean areas in which SURTASS LFA sonar operations may occur during the annual LOA effective period, from August 15 to August 14 of each year.

Annually, each SURTASS LFA sonar vessel is expected to spend approximately 54 days in transit and 240 days at sea conducting routine training, testing, and military operations. The actual number and length

References to Underwater Sound Levels

- References to underwater sound pressure level (SPL) in this FCR 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 (Urick, 1983; ANSI, 2006).
- Underwater sound exposure level (SEL) is a measure of energy, specifically the squared instantaneous pressure integrated over time; the appropriate units for SEL are dB re 1 μPa^2-sec (Urick, 1983; ANSI, 2006; Southall et al., 2007).
- The term "Single Ping Equivalent" (SPE) used herein is an intermediate calculation for input to the risk continuum used in the acoustic impact analysis for SURTASS LFA sonar. SPE accounts for the energy of all LFA sonar transmissions that a modeled animal ("animat") receives during a 24-hr period of a SURTASS LFA sonar mission as well as an approximation of the manner in which the effect of repeated exposures accumulate. As such, the SPE metric incorporates both physics and biology. Calculating the potential risk from exposure to SURTASS LFA sonar is a complex process. SPE levels will be expressed as "dB SPE" in this document, as they have been presented in the environmental compliance documentation for SURTASS LFA sonar: FOEIS/FEIS (DoN, 2001); FSEIS (DoN, 2007); FSEIS/SOEIS (DoN, 2012a); FSEIS/SOEIS (DoN, 2015); and DSEIS/SOEIS (DoN, 2016).

of the individual missions within the 240 days are difficult to predict, but the maximum number of LFA sonar transmission hours will not exceed 432 hours per vessel per year.

Whenever LFA sonar is operating (transmitting), mitigation measures includes visual, passive acoustic, and active acoustic (high frequency/marine mammal mitigation [HF/M3 sonar]) monitoring to prevent potential adverse effects to marine mammals (and sea turtles) to the extent practicable. Monitoring occurs in the mitigation zone for SURTASS LFA sonar, which is the range from the transmitting sonar system to the 180 dB re 1 µPa rms isopleth. NMFS has implemented an additional 0.54 nmi (1 km) buffer zone surrounding the LFA sonar mitigation zone. These measures provide a method to detect marine mammals within the mitigation and buffer zones for SURTASS LFA sonar and delay/suspend transmissions accordingly.

2 MITIGATION, MONITORING, AND REPORTING

2.1 MITIGATION

Mitigation protocols, operational restrictions, and mitigation monitoring requirements under which the Navy is authorized to operate SURTASS LFA sonar were set forth in the 2012 Record of Decision (ROD; DoD, 2012), MMPA Final Rule (NOAA, 2012), and in the annual LOAs. The goal of the complete suite of mitigation and monitoring measures required for the employment of SURTASS LFA sonar are to minimize, to the greatest extent practicable, adverse impacts on marine mammal species, stocks, or their habitat. These objectives are met through geographical restrictions on LFA sonar employment; maintenance of a mitigation and buffer zone around the transmitting LFA sonar source; monitoring by visual (daylight hours only), passive acoustics, and active acoustics whenever LFA sonar is transmitting; ramp-up procedures for the HF/M3 sonar system; suspension or delay of LFA sonar transmissions when marine mammals or sea turtles are detected in the mitigation or buffer zones; and mission planning.

2.1.1 Geographic Restrictions

Transmission of SURTASS LFA sonar is restricted in certain geographic areas including the coastal standoff range, offshore biologically important areas (OBIAs), and known human diver locations, wherein the sound field generated by LFA sonar cannot exceed specific received levels. SURTASS LFA sonar transmissions will not exceed 180 dB re 1 µPa (rms) within 12 nautical miles (nmi) (22 kilometers [km]) of all land masses with a coastline (regardless of size and including islands) (i.e., coastal standoff range; LOA Condition 8(h)(i)) or within 0.54 nmi (1 km) of the outer perimeter of any OBIA (LOA Condition 8h(ii). In addition, the received sonar sound field at recreational dive sites cannot exceed 145 dB re 1 µPa (rms).

2.1.1.1 Offshore Biologically Important Areas

OBIAs are areas of the world's oceans that are located outside the coastal standoff range (i.e., >12 nmi [>22 km] from land) where marine mammals aggregate in high densities to conduct biologically important activities such as breeding/calving, foraging, or migration. In the 2012 SEIS/SOEIS (DoN, 2012), the Navy designated 21 OBIAs for SURTASS LFA sonar, while NMFS designated an additional OBIA in the 2012 MMPA Final Rule (NOAA, 2012) (Table 2-1). As noted, the sound field generated by SURTASS LFA sonar cannot exceed 180 dB re 1 µPa (rms) within 0.54 nmi (1 km) of an OBIA during the effective period for each OBIA (i.e., the time of year during which the biologically important activity occurs). During military operations, however, SURTASS LFA sonar transmissions may exceed 180 dB re 1 µPa (rms) within the boundaries of SURTASS LFA sonar OBIAs when: 1) operationally necessary to continue tracking an existing underwater contact; or 2) operationally necessary to detect a new underwater contact within the OBIA (50 CFR 218.234(g)(1) and LOA Condition 8h(i)).

Until 2016, the Navy was authorized to operate in mission areas of the western and central North Pacific Ocean where only one of the 22 OBIAs designated for SURTASS LFA sonar is located (Table 2-2). OBIA 16, Hawaiian Islands Humpback Whale National Marine Sanctuary, Penguin Bank, with the effective period of important biological activity occurring from November through April, annually, is located in the Hawaii South mission area for SURTASS LFA sonar. However, no SURTASS LFA sonar missions occurred in the Hawaii North or South mission areas during August 2012 through November 2016.

Table 2-1. SURTASS LFA Sonar Offshore Biologically Important Areas (OBIAs) Designated for Marine Mammals and their Period of Effectiveness.

OBIA Number	*OBIA*	*Period of Effectiveness*
1	Georges Bank	Year-round
2	Roseway Basin Right Whale Conservation Area	June through December, annually
3	Great South Channel, U.S. Gulf of Maine, and Stellwagen Bank NMS	January 1 to November 14, annually
4	Southeastern U.S. Right Whale Seasonal Habitat	November 15 to April 15, annually
5	North Pacific Right Whale Critical Habitat	March through August, annually
6	Navidad Bank	December through April, annually
7	Coastal waters of Gabon, Congo and Equatorial Guinea	June through October, annually
8	Patagonian Shelf Break	Year-round
9	Southern Right Whale Seasonal Habitat	May through December, annually
10	Central California National Marine Sanctuaries	June through November, annually
11	Antarctic Convergence	October through March, annually
12	Piltun and Chayvo Offshore Feeding Grounds in the Sea of Okhotsk	June through November, annually
13	Coastal waters off Madagascar	July through September, annually for humpback whale breeding and November through December, annually for migrating blue whales
14	Madagascar Plateau, Madagascar Ridge, and Walters Shoal	November through December, annually
15	Ligurian-Corsican-Provencal Basin and Western Pelagos Sanctuary in the Mediterranean Sea	July to August, annually
16	Hawaiian Islands Humpback Whale NMS and Penguin Bank	November through April, annually
17	Costa Rica Dome	Year-round
18	Great Barrier Reef between 16° S and 21° S	May through September, annually
19	Bonney Upwelling off the southern coast of Australia	December through May, annually
20	Northern Bay of Bengal and Head of Swatch-of-No-Ground	Year-round
21	Olympic Coast NMS, The Prairie, Barkley Canyon, and Nitnat Canyon	Olympic NMS: December, January, March, and May, annually The Prairie, Barkley Canyon, and Nitnat Canyon: June through September, annually
22	Abrolhos Bank	August through November, annually

Table 2-2. Mission areas for SURTASS LFA missions authorized through August 2017 in the western and central North Pacific Ocean and Indian Ocean.

Mission Area Number	*SURTASS LFA Mission Area*
Western North Pacific Ocean	
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° N)
9	Offshore Japan (10° to 25° N)
15	Northeast of Japan
Central North Pacific Ocean	
10	Hawaii North
11	Hawaii South
Indian Ocean	
12	Arabian Sea
13	Andaman Sea
14	Northwest of Australia

In August 2016, the Navy expanded its annual authorized mission areas to include the Indian Ocean (Table 2-2). Three candidate OBIAs are located in areas of the Indian Ocean authorized under the 2016 to 2017 LOAs. The Navy has agreed to treat these areas as OBIAs and will not transmit SURTASS LFA sonar at received levels above 180 dB SPL (rms) within 0.54 nmi (1 km) of the boundary of these potential OBIAs during the periods of biologically important activities for the purpose of the 2016 to 2017 LOAs pending a final decision on their designation (NOAA, 2016).

2.1.2 Mitigation and Buffer Zone

The mitigation zone for SURTASS LFA sonar encompasses an ocean volume ensonified to a RL greater than 180 dB re 1 µPa (rms) by LFA sonar transmissions. Based on spherical spreading, this zone will vary between the nominal horizontal ranges of 0.40 to 0.54 nmi (0.75 to 1.0 km) over a depth of approximately 285 to 515 feet (ft) (87 to 157 meters [m]) from the LFA sonar source array, with the center of the LFA sonar source array located at an approximate depth of 400 ft (122 m) below the sea surface. Under rare environmental conditions (e.g., strong acoustic duct), this range could be somewhat greater than 0.54 nmi (1 km). Knowledge of local environmental conditions (such as sound speed

profiles [depth versus sound speed] and sea state) that affect sound propagation is critical to maintaining the appropriate mitigation zone distance.

To determine the distance to the 180-dB rms isopleth (radius of the LFA mitigation zone) from the LFA sonar source, local environmental data and underwater acoustic prediction models are used to determine the propagation of the LFA sonar signal in real-time. These sound field estimates are completed prior to and during LFA sonar transmissions. The propagation of the LFA sound field is updated at least every 12 hours, if not more frequently as meteorological or oceanographic (environmental) conditions vary (LOA Condition 8[c]). If the sound field analysis indicates that the distance to the 180-dB re 1 µPa isopleth (i.e., radius of the mitigation zone) has changed, the Officer in Charge (OIC) of the military crew (MILCREW) aboard the SURTASS LFA sonar vessels notifies the pertinent crewmembers conducting visual and acoustic mitigation monitoring so that their monitoring procedures incorporate the correct mitigation zone distance.

To minimize further the potential for injury to marine mammals, per the 2012 MMPA Final Rule and annual LOAs, NMFS requires an additional 0.54-nmi (1-km) buffer zone that is added to the LFA mitigation zone. Thus, the mitigation zone plus the buffer zone is monitored for marine mammal or sea turtle presence during LFA sonar transmissions, and if a marine mammal or turtle is detected, LFA sonar transmissions are suspended or delayed. While the implementation of this additional buffer zone has proven to be practicable under current operations, the Navy's analysis indicates that adverse impacts below 180-dB re 1 µPa (rms) RL were not minimized appreciably (DoN, 2007).

During 2012 through 2016 period, the Navy measured the at-sea range to the 180-dB rms isopleth when LFA sonar was transmitting, and reported that range in each of its 17 classified quarterly mission reports submitted to NMFS. As would be expected, the range to the 180-dB rms isopleth fluctuated slightly due to dynamic acoustical conditions.

2.1.3 Ramp-Up Procedures for HF/M3 Sonar

Prior to transmission of SURTASS LFA sonar for any purpose, the power level of the HF/M3 sonar system is to be ramped up over a period of no less 5 minutes from the maximum starting SL of 180 dB re 1 µPa @ 1 m (rms) (SPL) in 10-dB increments until the operating level is attained. This ramp-up of the HF/M3 sonar system ensures that there are no inadvertent exposures of marine mammal or sea turtles close to the SURTASS LFA sonar vessel to RLs greater or equal to 180 dB re 1 µPa (rms) from the HF/M3 sonar. This ramp-up procedure is to be conducted at least 30 minutes prior to any SURTASS LFA sonar transmission, prior to LFA sonar calibrations or testing that are not part of regular LFA sonar transmissions, and any time the HF/M3 sonar has been powered down for more than two minutes. If a marine mammal is detected during the ramp-up procedure, the SPL of the HF/M3 sonar is not to be increased. Once marine mammals are no longer detected by visual or passive acoustic monitoring, the HF/M3 ramp-up process may resume.

2.1.4 Mission Planning

The Navy must ensure that no more 12 percent of any marine mammal stock is taken by MMPA Level B harassment during an annual LOA period. To accomplish this requirement, the Navy coordinates the mission planning for the SURTASS LFA sonar vessels and mission areas in which they operate and maintains a running total of the percentage of each marine mammal stock taken by MMPA Level B harassment by all LFA sonar operations of all four SURTASS LFA sonar vessels during that annual period.

During the 2012 to 2016 period covered in this FCR, the Navy's estimates of marine mammal stocks taken by MMPA Level B harassment never exceeded 6.4 percent annually.

2.1.5 Mitigation Monitoring to Prevent Injury to Marine Mammals

The purpose of mitigation monitoring is to 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. In accordance with the Navy's 2012 ROD (DoD, 2012), 2012 MMPA Final Rule (50 CFR §218.235) (NOAA, 2012), and LOA conditions 9 and 10, three types of mitigation monitoring (Table 2-3) are conducted onboard LFA sonar vessels when SURTASS LFA sonar is transmitting:

- **Visual monitoring** from the bridge of the SURTASS LFA sonar vessel during daylight hours by personnel trained to detect and identify marine mammals using standard (7x) binoculars and the naked eye;
- **Passive acoustic monitoring** using the passive low-frequency (LF) SURTASS array to listen for sounds generated by marine mammals as an indicator of their presence; and
- **Active acoustic monitoring** using the HF/M3 sonar, which is a Navy-developed, enhanced HF commercial sonar used to detect, locate, and track marine mammals (and sometimes sea turtles).

Monitoring must commence at least 30 minutes before the first SURTASS LFA sonar transmissions, continue between sonar transmissions (pings), and persist until 15 minutes after the completion of SURTASS LFA sonar transmissions (or 30 minutes after sunset for visual monitoring) or until such time as marine mammals showing abnormal behavioral patterns return to normal or conditions prevent continued observations.

Additionally, marine mammal biologists qualified in conducting visual at-sea monitoring for marine mammals are to train the personnel of SURTASS LFA sonar vessels designated to conduct visual monitoring. These crewmembers are to be trained in conducting at-sea visual monitoring and in effectively communicating information about their visual detections within their command structure.

2.1.5.1 Visual Monitoring

Visual monitoring includes daytime observations for marine mammals and sea turtles from the SURTASS LFA sonar vessel. Daytime is defined as 30 minutes before sunrise until 30 minutes after sunset. Visual monitoring begins 30 minutes before sunrise or 30 minutes before the SURTASS LFA sonar is deployed and continues until 30 minutes after sunset or until the SURTASS LFA sonar is recovered aboard the vessel. Observations are made by civilian ship personnel trained in detecting and identifying marine mammals and sea turtles from the ship's bridge using standard binoculars (7x) and the naked eye. The objective of visual monitoring is to ensure that no marine mammal or sea turtle approaches close enough to enter the LFA mitigation zone, where a marine mammal might be impacted by LFA sonar transmissions.

The trained visual observers maintain a topside watch for marine mammals and sea turtles at the sea surface during operations when SURTASS LFA sonar is transmitting. The numbers and identification of observed marine mammals or sea turtles, as well as any unusual behavior, are entered into a log. A designated ship's officer monitors the conduct of the visual watches and periodically reviews the log entries. If a potentially affected marine mammal or sea turtle is sighted anywhere within the LFA mitigation or buffer zones, the visual observer notifies the officer on watch, who relays the information

Table 2-3. Summary of Mitigation Monitoring Measures to Prevent Injury to Marine Mammals Whenever SURTASS LFA Sonar is Transmitting.

Mitigation Monitoring Measure	*Criteria*	*Actions*
Visual Monitoring	Potentially affected species near the vessel but outside the LFA mitigation zone plus 1-km (0.54-nmi) buffer zone	MILCREW OIC notified and animals tracked for possible intersection with mitigation/buffer zone
	Potentially affected species sighted inside the LFA mitigation zone plus 1-km (0.54-nmi) buffer zone	SURTASS LFA sonar transmissions delayed/suspended
Passive Acoustic Monitoring	Marine mammal species detected in the LFA mitigation zone plus 1-km (0.54-nmi) buffer zone	MILCREW OIC notified; SURTASS LFA sonar transmissions delayed/suspended
Active Acoustic (HF/M3) Monitoring	Contact detected and determined to have a track that would pass within the LFA mitigation zone plus 1-km (0.54-nmi) buffer zone	MILCREW OIC notified and animals tracked for possible intersection with mitigation/buffer zone
	Potentially affected species detected inside the LFA mitigation zone plus 1-km (0.54-nmi) buffer zone	SURTASS LFA sonar transmissions delayed/suspended

to the military crew (MILCREW) officer-in-charge (OIC), who then orders the immediate delay or suspension of SURTASS LFA sonar transmissions. Similarly, if a marine mammal or sea turtle were sighted outside the LFA mitigation or buffer zones, the bridge officer would notify the MILCREW OIC of the estimated range and bearing of the observed marine mammal or sea turtle. The MILCREW OIC then notifies the HF/M3 sonar operator to verify or determine the range and projected track of the detected marine mammal/sea turtle. If the sonar operator determines that the animal will pass into the LFA mitigation or buffer zones, the MILCREW OIC orders the immediate delay or suspension of SURTASS LFA sonar transmissions when the animal enters the LFA mitigation/buffer zones. The visual observer continues visual monitoring and recording until the marine mammal/sea turtle is no longer observed. SURTASS LFA sonar transmissions only commence/resume 15 minutes after there are no further detections of marine mammals or sea turtles by visual, active acoustic (HF/M3 sonar), or passive acoustic monitoring within the LFA mitigation/buffer zones. If a detected marine mammal were exhibiting abnormal behavior, visual monitoring is to continue until the observed behavior returns to normal or conditions do not allow monitoring to continue.

From August 2012 through November 2016, the civilian crewmembers of the SURTASS LFA sonar vessels monitoring the sea surface for marine mammals or sea turtles during LFA sonar missions reported 15 detections of marine animals (Table 2-4). The visual detections included groups of dolphins and whales, a black-finned marine mammal, one sea turtle, and two groups of tuna.

2.1.5.2 Passive Acoustic Monitoring

Passive acoustic monitoring is conducted using the SURTASS towed HLA to listen for vocalizing marine mammals as an indicator of their presence. If a detected sound is estimated to be from a vocalizing

Table 2-4. Number of Mitigation Monitoring Detections and the Associated Number of Delays or Suspensions of LFA Sonar Transmissions for Each Annual LOA Period and Over the 5-Year Final Rule Period to Date.

Annual Period by T-AGOS Vessel	Number Visual Detections	Number Passive Acoustic Detections	Number Active Acoustic (HF/M3) Detections	Number Suspensions/ Delays of LFA Sonar Transmissions Due to Mitigation Protocol
LOA 1: 2012-2013				
USNS VICTORIOUS	0	0	1	1
USNS ABLE	0	0	0	0
USNS EFFECTIVE	0	3	9[2]	9
USNS IMPECCABLE	0	0	0[2]	0[2]
LOA 2: 2013-2014				
USNS VICTORIOUS	0	0	1	1
USNS ABLE	0	0	4[2]	4
USNS EFFECTIVE	0	0	0	0
USNS IMPECCABLE	0	0	0	0
LOA 3: 2014-2015				
USNS VICTORIOUS	0	0	0	0
USNS ABLE	0	0	1	1
USNS EFFECTIVE	5	0	5	9
USNS IMPECCABLE	1	0	1	1
LOA 4: 2015-2016				
USNS VICTORIOUS	4	0	7	8
USNS ABLE	0	0	0	0
USNS EFFECTIVE	5	3	21	21
USNS IMPECCABLE	0	0	0	0
LOA 5: 2016-2017 (Quarter 1)				
USNS VICTORIOUS	0	0	0	0
USNS ABLE	0	0	1	1
USNS EFFECTIVE	0	0	0	0
USNS IMPECCABLE	0	0	0	0
Totals	**15**	**6**	**51**	**55**

marine mammal that may be potentially affected by SURTASS LFA sonar, the passive acoustic sonar technician notifies the MILCREW OIC, who alerts the HF/M3 sonar operator and visual observers (during daylight). The delay or suspension of SURTASS LFA sonar transmissions is ordered when the HF/M3 sonar and/or visual observation indicates the marine mammal's range is within the LFA mitigation or buffer zone. Passive acoustic sonar technicians identify the detected vocalizations to marine mammal

2 Since this LOA period and due to the number of system faults and other equipment issues that were being reported as mitigation-related detections or suspensions of LFA sonar, the Navy changed its criteria and reporting for HF/M3 detections so that non-mitigation related causes are not reported as HF/M3 mitigation detections or related suspensions or delays of LFA sonar transmissions. For consistency in reporting of this 2012 to 2017 5-year Rule period, only detections of possible marine animals and the associated suspensions/delays of LFA sonar transmissions per mitigation protocol are reported herein; thus, some values may differ from what was originally reported in the annual report for this period.

species whenever possible. As with the other types of monitoring, passive acoustic monitoring begins 30 min prior to the first LFA sonar transmission, continues throughout all LFA sonar transmissions, and ceases at least 15 minutes after LFA sonar transmissions are no longer broadcast.

During the 2012 through 2016 effective periods covered in this FCR, six passive acoustic detections were made within the LFA mitigation and buffer zones (Table 2-4). Passive acoustic training of sonar operators aboard the Navy's SURTASS LFA sonar vessels began near the end of the 2014 effective LOA period. As a result of the initiation of this training, the Navy's sonar operators became aware that reports of passive acoustic detections outside of the mitigation and buffer zones also could provide valuable occurrence information about marine mammal vocalizations, especially when they could be identified to species. Thereafter, reports of passive acoustic detections of marine mammals outside the ranges of the mitigation plus buffer zones have been reported in the quarterly mission summaries of SURTASS LFA sonar missions. Since the beginning of the 2014 to 2015 effective LOA period, 76 detections of marine mammals have been reported outside the mitigation/buffer zones. Of the detections that could be identified to species, the majority were identified as Bryde's whales but humpback, fin, and one blue whale were also identified by the passive sonar operators aboard the SURTASS LFA sonar vessels.

2.1.5.3 Active Acoustic Monitoring

HF active acoustic monitoring uses the HF/M3 sonar to detect, locate, and track marine mammals (and possibly sea turtles) that could pass close enough to the SURTASS LFA sonar array to enter the LFA mitigation or buffer zones. HF/M3 sonar monitoring begins 30 minutes before the first SURTASS LFA sonar transmission is scheduled to commence and continues until 15 minutes after LFA sonar transmissions are terminated. Prior to full-power operations, the HF/M3 sonar power level would be ramped up over a period of 5 minutes from the SL of 180 dB re 1 µPa @ 1 m (rms) (SPL) in 10 dB increments until full power (if required) is attained. This power ramp-up ensures that marine mammals or sea turtles are not inadvertently exposed to RLs ≥180 dB re 1 µPa (rms) from the HF/M3 sonar.

If a contact is detected during HF/M3 monitoring within the LFA mitigation or buffer zones, the sonar operator notifies the MILCREW OIC, who orders the immediate delay or suspension of LFA sonar transmissions. Likewise, if HF/M3 monitoring were to detect a possible marine mammal or sea turtle outside the LFA mitigation zone, the HF/M3 sonar operator would determine the range and projected track of the marine mammal or sea turtle and notify the MILCREW OIC that a detected animal may pass into the LFA mitigation/buffer zones. The MILCREW OIC notifies the bridge visual observers and passive sonar operator of the potential presence of a marine animal projected to enter the mitigation/buffer zones. The MILCREW OIC orders the delay or suspension of LFA sonar transmissions when the marine mammal/sea turtle is predicted to enter the LFA mitigation/buffer zones. SURTASS LFA sonar transmissions commence/resume 15 minutes after there are no further detections by the HF/M3 sonar, visual, or passive acoustic within the LFA mitigation/buffer zones.

To date since August 2012, per mitigation monitoring protocol, 51 detections of possible marine animals have been made by the HF/M3 sonar system during the 44 at-sea missions conducted during the period (Table 2-4). The detection rate of the HF/M3 sonar system is the highest of the three mitigation monitoring methods used whenever LFA sonar is transmitting.

2.1.5.4 Suspension/Delay of LFA Sonar Transmissions

Per the protocol specified in the Final Rule, annual LOAs, and Navy Executive Direction Message, LFA sonar transmissions are to be either immediately suspended or delayed if a marine mammal (or sea turtle) is detected within the mitigation and buffer zones. LFA sonar transmissions may resume/commence when there have been no further detections within the LFA mitigation and buffer zones of a marine mammal or sea turtle for 15 minutes.

To date since August of 2012, as the result of visual, passive acoustic, or HF/M3 sonar detections of possible marine mammals or sea turtles, LFA sonar transmissions were suspended or delayed a total of 55 times during the 44 LFA sonar missions conducted during this period (Table 2-4).

2.2 MONITORING

In addition to designating qualified personnel to conduct the mitigation, monitoring, and reporting required by the MMPA rulemaking and annual LOAs for SURTASS LFA sonar employment, the Navy also cooperates with NMFS and other Federal agencies in monitoring the impacts potentially associated with SURTASS LFA sonar activities. Further, the Navy is tasked with conducting four types of monitoring actions designed to increase the knowledge of affected marine mammal species or their environment.

2.2.1 Beaked Whale and Harbor Porpoise Research

To increase understanding of how harbor porpoises and beaked whale species might respond behaviorally and physiologically when exposed to SURTASS LFA sonar transmissions, the 2012 MMPA rulemaking for SURTASS LFA sonar employment (NOAA, 2012) charged the Navy with assessing different types of monitoring and research that might address this goal. The Navy was to convene a Scientific Advisory Group (SAG) of recognized scientific subject matter experts to identify feasible monitoring and/or research options the Navy could implement to assess the potential for effects from SURTASS LFA sonar on beaked whales or harbor porpoises. The SAG recommendations are considered independent scientific findings that are fully accessible to the public. Following the Navy's receipt of the SAG research or monitoring recommendations, per the MMPA Final Rule, the Navy is to prepare a plan of action outlining their strategy for implementing the SAG's recommendations or describe, in writing, why none of the SAG's recommendations are feasible and meet with NMFS to discuss any other potential options (NOAA, 2012). Per condition 12(a) of the 2015 to 2016 LOAs for SURTASS LFA sonar, the Navy is to consider the recommendations on the different types of monitoring/research that may increase the understanding of the potential effects of SURTASS LFA sonar transmissions on beaked whales and/or harbor porpoises.

Following the submittal of the Scientific Advisory Group (SAG) report, the Navy twice convened the EOG, composed of Navy and NMFS personnel as well as a representative of the Marine Mammal Commission. The purpose of the EOG is to provide the Navy with: 1) independent, objective review of the SAG's findings, 2) research guidance and prioritization, and 3) final recommendations to the Navy and NMFS on research efforts to ascertain effects of exposure to SURTASS LFA sonar specifically addressing beaked whale species and harbor porpoises. The members of the EOG recommended additional lower-cost research and monitoring studies based on existing occurrence and underwater acoustic vocalization data. One of the first efforts the EOG recommended was determining if any overlap existed between the geographic locations of possible SURTASS LFA sonar operations and the geographic range of harbor porpoises, since harbor porpoises typically occur in cold-temperate and sub-arctic coastal waters.

Examination of this overlap is in progress but has proven to be more geospatially complex to depict accurately the possible bathymetric extents of harbor porpoises in various global regions.

2.2.2 Passive Acoustic Monitoring

Since the SURTASS component is such an effective passive acoustic monitoring system and since the Navy also collects passive acoustic information from fixed and mobile acoustic monitoring platforms such as SURTASS, NMFS has included several conditions in its annual LOAs related to passive acoustic monitoring. Condition 12b of the annual LOAs for SURTASS LFA sonar requires the Navy to continue to assess data acquired and compiled by the 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 the M3 program's data that are determined to be unclassified after appropriate security reviews are to be made publicly available. LOA Condition 12(c) states that the Navy continue to explore the feasibility to use the SURTASS towed HLA with other Navy assets or range monitoring programs to augment the collection of data on marine mammal vocalizations prior to, during, or after Navy exercises. Additionally, under LOA condition 12(d), the Navy is to continue collecting data on ambient underwater noise and explore the feasibility of declassifying and archiving the data for future incorporation into oceanic underwater noise budgets and databases.

2.2.2.1 Marine Mammal Monitoring (M3) Program

SURTASS LFA sonar's M3 program uses the Navy's fixed and mobile passive acoustic monitoring systems to enhance the Navy's collection of long-term data on individual and population levels of acoustically active marine mammals, principally baleen whales. The M3 program collects acoustic data on the normal behavioral range of vocalizing (calling and singing) whales and on the influences of anthropogenic activities on normal whale behaviors. The acoustic data the M3 program observes, collects, and analyzes are electronically archived in a form that can be used for exercise planning, naval operations, system tests, and preparation of environmental compliance documents.

At present, the M3 program's data are classified, as are the data reports created by M3 analysts, due to the inclusion of sensitive national security information. In the past, however, researchers have based unclassified research and the resulting scientific papers on information from classified M3 program data or other Navy passive acoustic assets. The Navy continues to assess and analyze M3 data collected from Navy passive acoustic monitoring systems and is working toward making some portion of that data, after appropriate security reviews, available to scientists with appropriate clearances and ultimately to the public. Progress has been achieved on addressing security concerns for the declassification of the results of a specific marine mammal dataset. A scientific paper has been prepared using this dataset as its basis and has been submitted to a prominent, peer-reviewed scientific journal for review and eventual publication.

The Navy recently authorized the release of the following information from the M3 program on the critically endangered Western North Pacific gray whale to marine mammal researchers participating in discussions with the International Union for Conservation of Nature (IUCN) and the International Whaling Commission about the Western North Pacific gray whale's status. Little is known about the location of the Western North Pacific gray whale's breeding or calving grounds or the fall and winter distribution once the whales leave their summer foraging grounds in the Sea of Okhotsk near Sakhalin

Island. The historical range of the Western North Pacific gray whale extended from Russian waters (Sea of Okhotsk and Pacific waters off Kamchatka Peninsula) southward to the tropical waters of southeastern China, but only a part of this range appears to be occupied presently (Jefferson et al., 2015; Jones and Swartz, 2009). Some evidence suggests that Western North Pacific gray whales migrate in fall through the East China Sea into the South China or at least as far south as Hainan Island in the Gulf of Tonkin off southeastern most China (Jones and Swartz, 2009).

In early fall 2011, a SURTASS LFA sonar vessel detected a unique acoustic signature with the passive SURTASS array during a mission in the East China Sea. The acoustic detection was recorded and analyzed by M3 program acousticians, who determined that the origin of the acoustic signature was most likely Western North Pacific gray whales. Since the original 2011 detection, the M3 program has regularly detected gray whale vocalizations in the East China Sea that are characterized by a 55 Hz frequency sweep. SURTASS LFA sonar vessels have detected these 55-Hz sweeps only in the shallow water of the East China Sea from fall through spring (i.e., September through March). The vocalization signals are further characterized as pulses of short duration (one second), often emitted in pairs or triplets, an inter-sweep interval of approximately three or four seconds, with a pattern of multiple harmonics (first harmonic very weak but the second and third harmonics typically are the strongest), and a limited detection range. Vocalizations from up to 11 individual Western North Pacific gray whales have been detected over two to three-hour periods. Normally the vocalizations have been identified from slowly moving single whales or from small groups of two to three whales as they migrate south in fall and north in spring.

2.2.2.2 Augmenting Marine Mammal Monitoring with SURTASS Passive Sonar

In recognition of the monitoring value of the SURTASS passive towed HLA, the Navy is exploring the feasibility of coordinating with other Navy fleet assets to use the SURTASS passive sonar to augment the collection of data on marine mammal vocalizations during Navy exercises and/or as an adjunct to Navy range monitoring programs. The goal would be to determine the extent, if any, of changes in marine mammal vocalizations that could have been caused by SURTASS LFA sonar or other Navy underwater acoustic systems during the exercise. Collection of such passive acoustic data would directly contribute to our knowledge of marine mammals' occurrences and responses, but would also most importantly augment the data available from the Low Frequency Sound Scientific Research Program on the potential responses of baleen whales to LF underwater sound. Such calibrated and validated data would be valuable not only to the Navy but would also potentially be useful to inform NMFS' environmental compliance assessment of underwater LF sonar systems.

For the SURTASS passive HLA to be used in Navy exercises or as an adjunct to range monitoring programs, long-term, detailed planning and a comprehensive data collection and analysis plan would be required that would have to mesh with existing or scheduled operational planning for Navy exercises or range monitoring efforts. One fundamental challenge to using one of the SURTASS LFA sonar vessels in any Navy exercise or range monitoring effort is removal of one of these surveillance assets from its national security mission. Other challenges in using the SURTASS system for monitoring of marine mammals during Navy exercises or range monitoring include:

- Scheduling of assets: availability of a SURTASS LFA sonar vessel to participate in the exercise, time for a T-AGOS vessel to transit to and from the exercise or range location (due to the vessel's

travel speed), and the time for pre- and post- exercise data collection and analysis of marine mammal vocalizations.

- Budgetary constraints: additional Navy budget allocations required for a T-AGOS ship to transit to and from the exercise location, additional time at sea for the SURTASS LFA sonar vessel to participate in the exercise including collecting data before and after the exercise for data calibration, and additional labor effort to process the collected data.
- Potential for qualified, professional marine mammal observers to be onboard the SURTASS LFA sonar vessel during the data collection efforts. This poses a challenge since there is typically little available space on the T-AGOS vessels for additional riders, and any observers would need to possess appropriate security clearances.
- Security measures: protocols would need to be developed to ensure that the marine mammal vocalization data collected onboard the SURTASS LFA sonar vessel, or any other data collected during the exercise, can be scrubbed of any potentially classified information, such that the marine mammal data can be unclassified for processing and analysis by other scientists.
- Reconciling the potential behavioral responses of marine mammals associated with SURTASS LFA sonar transmissions versus other Navy underwater sound sources (e.g., mid-frequency active sonars).
- Accounting for other variables that may cause a change in marine mammals' vocalization output; this would be a task for a scientific team made up of marine biologists, LFA sonar operators, and oceanographic experts.

Despite these challenges, the Navy is exploring and evaluating the budgetary and logistical constraints to make this goal achievable, although it is likely to be several annual cycles before such a goal can be achieved due to the nature of forward budgetary planning.

2.2.2.3 Ambient Noise Monitoring

Ambient noise is the typical or persistent background noise that is present in the marine environment. Ambient noise is broadband in all frequencies and directional both horizontally and vertically. Ambient noise is generated both by natural (e.g., shrimp and fishes) and anthropogenic sources (e.g., shipping and seismic sonar).

The Navy acknowledges the value of the ambient noise data it routinely collects and continues to explore and discuss the feasibility of declassifying portions of these data after all related security concerns have been resolved. SURTASS LFA sonar's M3 program is working to compile information on the complete catalog of ambient noise data that have been collected from various Navy fixed and mobile passive acoustic systems as a starting point for further discussions on data dissemination, either at a classified or unclassified level.

2.2.3 Stranding Incident Monitoring

The Navy must ensure that its at-sea SURTASS LFA sonar operations are monitored for injured or disabled marine mammals and that the principal marine mammal stranding networks and media are monitored for correlative strandings that overlap in time and space with SURTASS LFA sonar operations. Per conditions of the LOAs and rulemaking for SURTASS LFA sonar, the Navy is responsible for

systematically observing SURTASS LFA sonar operations for injured or disabled marine mammals and monitoring 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 operations. Additionally, the Navy must notify NMFS immediately, or as soon as clearance procedures allow, if an injured, stranded, or dead marine mammal is found during, shortly after, and in the vicinity of any SURTASS LFA operations or anytime an injured, stranded, or dead marine mammal is found.

No injured or disabled marine mammals were observed during any of the 44 at-sea sonar missions to date in the August 2012 through November 2016 period. Monitoring of all available media and known stranding databases was conducted for strandings in the western North Pacific Ocean in which the Navy conducted LFA sonar missions during the annual period. Strandings were monitored by e-news alerts notifying the Navy and NMFS in real-time of stranding events, via social media for domestic and international stranding organizations, and by searching available stranding networks for relevant regional information. From August 2012 through November 2016, numerous individual marine mammal strandings and even several mass strandings of marine mammals were reported in areas of the western North Pacific Ocean in which SURTASS LFA sonar mission areas are located and in which SURTASS LFA sonar at-sea missions were conducted. No mass or individual strandings of marine mammals occurred anywhere near the location where SURTASS LFA sonar missions were conducted. No SURTASS LFA sonar operations could be correlated spatially or temporally to any of the strandings reported in the western North Pacific during the August 2012 through November 2016 period. No SURTASS LFA sonar operations occurred in the Hawaiian or Indian Ocean missions areas during these periods. From the commencement of SURTASS LFA sonar use in 2002 through the present, neither LFA sonar nor operation of T-AGOS vessels has been associated with any mass or individual strandings of marine mammals.

2.3 REPORTING

During routine training, testing, and military operations of SURTASS LFA sonar, technical and environmental data are collected and recorded, including data on visual and acoustic monitoring, ocean environmental measurements, and sonar transmission data. As stipulated in the MMPA Final Rule and LOAs, the following reporting for SURTASS LFA sonar is required as part of the Navy's authorizations:

- Quarterly classified and unclassified mission reports for each SURTASS LFA sonar vessel must be submitted within 30 days following the end of each quarter beginning on the date of the LOA's effectiveness. Even if no missions were conducted by a vessel, a report of negative activity must be submitted. Dates, times, and locations of each SURTASS LFA sonar mission will be included in the classified quarterly mission reports, while information on LFA sonar transmissions, including the number of times the sonar transmissions were suspended or delayed due to mitigation protocol procedures, will be included in both the unclassified and classified mission reports. The distance from the LFA sonar array to the 180 dB re 1 µPa (rms) isopleth is also to be noted. Additionally, any detection of marine mammals, including their range and bearing to the SURTASS LFA sonar vessel will be reported. Incidental take estimates of marine mammals possibly exposed to the duration of the each mission's LFA sonar transmissions that quarter are to be detailed in the report as well as the running total of affected stock percentages over the annual period.
- An annual report, which is the unclassified summary of all quarterly reports, is to be submitted to NMFS 45 days after the expiration of the LOAs. In addition to the summary of all annual LFA

sonar operations, the annual report should include the Navy's estimates of the marine mammal stocks affected by all SURTASS LFA sonar vessel operations for the annual effective LOA period, summary of the mitigation effectiveness, and an assessment of any long-term or discernable cumulative effects associated with exposure of marine mammals to SURTASS LFA sonar transmissions.

- A final comprehensive report (FCR), which is an unclassified assessment of any impacts of SURTASS LFA sonar on marine mammal stocks during the 5-year period of the MMPA regulations, is submitted to NMFS at least 240 days prior to expiration of the MMPA Final Rule regulations. In addition to summarizing all SURTASS LFA sonar operations and all information required by the annual LOAs, the FCR is also to include an unclassified analysis of new passive sonar technologies and an assessment of whether such systems are feasible alternatives to SURTASS LFA sonar (NOAA, 2012).
- A research action plan that outlines the Navy's strategy for implementing recommendations on beaked whales and/or harbor porpoise research on the effects of exposure to SURTASS LFA sonar is to be submitted to NMFS. However, if such research is not feasible/or is unlikely to increase the understanding of the potential effects of SURTASS LFA sonar transmissions on beaked whales and/or harbor porpoises, written documentation describing the reasons for this decision will be submitted to NMFS, to be followed by a meeting with NMFS to discuss any other potential options.
- Status update provided as part of the Navy's LOAs application on its efforts to assess the data collected by the M3 program and its progress toward making some portion of that data, after appropriate security reviews, available to scientists with appropriate clearances.

2.3.1 Quarterly Mission Reports

On a quarterly basis beginning with the effective date of the LOAs for SURTASS LFA sonar, August 15th of each year, the Navy has provided NMFS with classified reports for each vessel that includes all active-mode missions as well as unclassified reports of negative activity (i.e., no LFA sonar missions conducted that quarter). The Navy also provides an unclassified version of any classified quarterly mission report so that the non-classified pertinent information can be reviewed by individuals lacking the appropriate security clearances necessary to access the classified reports.

The Navy must submit its quarterly mission reports to NMFS no later than 30 days after the end of each quarter, beginning on the LOA date of effectiveness (August 15th) or as specified in the appropriate LOA. Specifically, the classified quarter mission reports will include dates and times of LFA sonar missions, location of vessel, SURTASS LFA sonar mission area, range of the mitigation zone (i.e., 180 dB rms isopleth) in relation to the LFA sonar array, detections of marine animals, and records of any delays or suspensions of LFA sonar operations. Detection information includes the taxa of the animal detected, identified to species if possible, number of animals, date and time of detections, type of detection (visual, passive acoustic, or HF/M3 sonar), the animal's bearing and range from the SURTASS LFA sonar vessel, behavior, and remarks/narrative (as necessary).

The quarterly mission report must include the Navy's assessment of whether any taking of marine mammals occurred within and outside of the SURTASS LFA sonar mitigation zone and, if so, estimates of the percentage of marine mammal stocks affected both for the quarter and cumulatively (to date) for

the annual period covered by the LOAs for SURTASS LFA sonar operations. The Navy's assessment includes estimates of Level A and Level B harassment takes of marine mammals in the LFA mitigation plus buffer zones using predictive modeling that is based on operating locations, dates/times of operations, system characteristics, oceanographic environmental conditions, and animal demographics.

During the 17 quarters period covered by this FCR, the Navy has submitted 29 classified quarterly mission reports that documented 44 SURTASS LFA sonar missions as well as 39 unclassified quarterly mission reports that reported negative LFA sonar activity (i.e., no sonar missions).

2.3.2 Annual Reports

SURTASS LFA sonar annual reports provide NMFS with an unclassified summary of the year's quarterly reports and include the Navy's assessment of whether any Level A and/or Level B harassment takings of marine mammals occurred within and outside of the SURTASS LFA sonar's 180-dB mitigation zone and, if so, estimates of the percentage of marine mammal stocks affected by SURTASS LFA sonar operations. The analysis is prepared using predictive modeling based on operating locations, dates/times of operations, system characteristics, oceanographic environmental conditions, and animal demographics. The annual reports include: (1) analysis of the effectiveness of the mitigation measures with recommendations for improvements where applicable; (2) assessment of any long-term effects from SURTASS LFA sonar operations; and (3) any discernible or estimated cumulative impacts from SURTASS LFA sonar operations.

Under the 2012 Final MMPA Rule for SURTASS LFA sonar, the Navy has submitted four annual reports to date. The fifth annual report for the 5-year period of the Rule will be submitted to NMFS in fall 2017.

2.3.3 Final Comprehensive Report

The Navy is required to provide NMFS and the public with a final comprehensive report analyzing the impacts of SURTASS LFA sonar on marine mammal species and stocks. This report, which is due at least 240 days prior to expiration of these regulations, includes an in-depth analysis of all mitigation monitoring and Navy-supported research pertinent to SURTASS LFA sonar conducted during the first 4 years of these regulations, a scientific assessment of cumulative impacts on marine mammal stocks, and an analysis on the advancement of alternative (passive) technologies as a replacement for LFA sonar. This report is an important document for NMFS' review and assessment of impacts for any future rulemaking.

2.4 Adaptive Management

Since the understanding of the potential effects of SURTASS LFA sonar on marine mammals is continuing to evolve, the MMPA Final Rule (NOAA, 2012) provided the adaptive management mechanism by which NMFS can modify or augment existing mitigation or monitoring measures, after consultation with the Navy, if doing so will have a reasonable likelihood of more effectively accomplishing the mitigation and monitoring objectives (50 CFR 218.241).

Over the period covered by this FCR, the Navy and NMFS held four adaptive management meetings for the SURTASS LFA sonar program. During these meetings, the status of the monitoring and reporting efforts for the employment of SURTASS LFA sonar were reviewed, potential OBIAs and the associated biological and spatial information pertinent to the areas were presented, as was recent scientific literature potentially relevant to SURTASS LFA sonar. The meetings were attended by representatives of the Navy, NMFS, the Marine Mammal Commission, and Navy support contractors.

3 SURTASS LFA SONAR OPERATIONS 2012 THROUGH 2016

During the period covered in this FCR, SURTASS LFA sonar systems onboard the USNS VICTORIOUS, USNS ABLE, USNS EFFECTIVE, and USNS IMPECCABLE were operated under the conditions of the annual LOAs, as issued. Throughout this period, the four SURTASS LFA sonar vessels conducted a total of 44 at-sea missions in four of the Navy's northwestern Pacific Ocean mission areas for SURTASS LFA sonar (Tables 2-2 and 3-1). However, as of August 2016, twelve mission areas have been authorized for operation for SURTASS LFA sonar in the western and central North Pacific Ocean while three additional mission areas are authorized in the Indian Ocean (Table 2-2). The following is a summary of each of the four SURTASS LFA sonar vessel's operations during the August 2012 through November 2016 period.

3.1 USNS VICTORIOUS OPERATIONS

From 15 August 2012 through 14 November 2016, the USNS VICTORIOUS (T-AGOS 19) completed eight SURTASS LFA sonar missions during which 30.08 hours of LFA sonar were transmitted (Table 3-1). From August 2012 through August 2016, the VICTORIOUS averaged two LFA sonar missions per annual period. The VICTORIOUS completed no LFA sonar missions in the first quarter of the 2016 to 2017 annual LOA period.

From August 2012 through November 2016, the USNS VICTORIOUS reported four visual, no passive acoustic, and nine active acoustic (HF/M3) detections of marine mammals or sea turtles during their eight missions (Table 2-4). These detections of possible marine animals resulted in 10 suspensions or delays of LFA sonar transmissions.

3.2 USNS ABLE OPERATIONS

During the period cover in this FCR, the USNS ABLE (T-AGOS 20) conducted 12 SURTASS LFA sonar missions with transmission of 51.2 hours in total of LFA sonar transmissions (Table 3-1). For the first four years of the 2012 to 2017 Final Rule effective period, the ABLE averaged 2.5 missions per annual LOA period during which an average of 10.1 hours of LFA sonar were transmitted. The ABLE conducted two SURTASS LFA sonar missions during the first quarter of the 2016 to 2017 LOA annual period.

Over the period covered in this FCR, the ABLE reported no visual, no passive acoustic, and six active acoustic (HF/M3 sonar) detections of marine animals during the 12 missions conducted (Table 2-4). LFA sonar transmissions were delayed or suspended six times as a result of the ABLE's mitigation detections.

3.3 USNS EFFECTIVE OPERATIONS

Of the SURTASS LFA sonar vessels, the USNS EFFECTIVE conducted the most SURTASS LFA sonar missions thus far during the 5-year Final Rule period (Table 3-1). The USNS EFFECTIVE (T-AGOS 21) conducted 19 of the 44 SURTASS LFA sonar missions, during which 100.75 hours of LFA sonar was transmitted. On average over the first four years of the MMPA Rule authorization period, the EFFECTIVE conducted 4.75 SURTASS LFA sonar missions per year and transmitted 25.19 hours of LFA sonar. No missions were conducted by the EFFECTIVE during the first quarter of the final annual period of the 2012 through 2017 Final MMPA Rule for SURTASS LFA sonar.

From August 2012 through November 2016, the EFFECTIVE reported 10 visual, 6 passive acoustic, and 35 active acoustic (HF/M3 sonar) detections of marine mammals or sea turtles during the 19 missions conducted (Table 2-4). These detection of marine animals resulted in 39 suspensions or delays of LFA sonar transmissions.

Table 3-1. Total Number of SURTASS LFA Sonar Missions and LFA Sonar Transmission Hours by Vessel and Annual LOA Effective Period as well as Totals from August 2012 through November 2016 of the Five-year MMPA Rule Period.

USNS T-AGOS Vessel	LOA 1: 2012-2013		LOA 2: 2013-2014		LOA 3: 2014-2015		LOA 4: 2015-2016		LOA 5: 2016-2017 (Qtr 1)		5-Yr to Date Totals	
	Number Missions	LFA Sonar Hours	Number Missions	LFA Sonar Hours	Number Missions	LFA Sonar Hours	Number Missions	LFA Sonar Hours	Number Missions	LFA Sonar Hours	Number Missions	LFA Sonar Hours
USNS VICTORIOUS (T-AGOS 19)	3	14.2	1	7.68	1	1.3	3	6.9	0	0	8	30.08
USNS ABLE (T-AGOS 20)	3	5.4	3	18.10	1	2.6	3	14.3	2	10.8	12	51.2
USNS EFFECTIVE (T-AGOS 21)	4	22.5	3	12.85	6	36.6	6	28.8	0	0	19	100.75
USNS IMPECCABLE (T-AGOS 23)	2	5.2	0	0	2	11.1	1	2.6	0	0	5	18.9
Total	**12**	**47.3**	**7**	**38.63**	**10**	**51.6**	**13**	**52.6**	**2**	**10.8**	**44**	**200.9**

3.4 USNS IMPECCABLE OPERATIONS

The USNS IMPECCABLE (T-AGOS 23) conducted a total of five SURTASS LFA sonar missions from August 2012 through November 2016 during which LFA sonar was transmitted for 18.9 hours (Table 3-1). Over the first four years of the Final Rule period for SURTASS LFA sonar, the IMPECCABLE averaged 1.25 missions per annual period and an average of 4.7 hours of LFA sonar transmissions. No SURTASS LFA sonar missions were conducted by the IMPECCABLE during the first quarter of the 2016 to 2017 annual LOA period.

Over the period covered in this FCR, the IMPECCABLE reported one visual, no passive acoustic, and one active acoustic (HF/M3 sonar) detections during their five missions (Table 2-4). These visual and HF/M3 detections resulted in one suspension/delay of LFA sonar transmissions.

4 AFFECTED MARINE MAMMAL STOCKS 2012 THROUGH 2016

In the quarterly and annual reports submitted for SURTASS LFA sonar, the Navy provided post-mission assessments of whether incidental harassment occurred within the LFA sonar mitigation and buffer zones and estimates of the percentages of marine mammal stocks and number of individual marine mammals estimated to have been harassed incidentally in association with exposure to actual SURTASS LFA sonar transmissions during the 15 August 2012 through 14 November 2016 reporting periods (Tables 4-1 to 4-5). These marine mammal incidental harassment estimates were derived using predictive modeling based on dates/times/location of operations, system characteristics, oceanographic/environmental conditions, and animal demographics (abundances and density estimates) for each of the four SURTASS LFA sonar vessels. The basis for the methodology used for the acoustic modeling to analyze risk and produce the incidental harassment estimates was essentially the scientific analysis process used in the SURTASS LFA Final SEIS/SOEIS (DoN, 2012).

Overall mission planning during each annual period of the Final Rule was fundamentally based on national security and operational anti-submarine warfare requirements as well as the need for incidental harassment associated with exposures of 120 to 180 dB SPE of any one stock of marine mammals to remain under 12 percent annually. Thus, mission planning for each quarter of each annual LOA period considered the running total of the estimated percentage of affected marine mammal stocks so that no more than 12 percent of any marine mammal stock would be taken by MMPA Level B harassment annually by all SURTASS LFA sonar vessels combined (LOA Condition 6). The same analysis methodology and population data (densities and abundances) were utilized to compute both the annual pre- and post-mission take estimations (pre-mission estimates included in the Navy's annual requests for LOAs). Since Omura's whales are not an authorized species under the MMPA Final Rule for SURTASS LFA sonar, the takes estimate values for Omura's whales that occur in some mission areas for SURTASS LFA sonar are combined with the closely related Bryde's whale and represented as Bryde's whales.

Over the period from 15 August 2012 through 14 November 2016, the highest annual percentage of any marine mammal stock harassed from exposure to all LFA sonar vessel's transmissions at 120 to 180 dB SPE was 6.38 percent for the Western North Pacific (WNP) O stock of the common minke whales (Tables 4-1 to 4-5). The Navy estimates the WNP O stock of common minke whales as 25,049 individuals. Thus, this 2015 to 2016 highest estimated percentage represents MMPA Level B "takes" of an estimated 1,598 individual common minke whales over the annual period. The next highest estimated annual percentage of any marine mammal stock affected at exposure levels of 120 to 180 dB SPE from all SURTASS LFA sonar vessels was 2.796 percent to the Central North Pacific (CNP) stock of Longman's beaked whales. This second highest annual percentage occurred in 2014 to 2015 and represents 28 individuals of the Longman's beaked whale CNP stock of 1,007 animals. The highest number of individual marine mammals affected at exposure levels of 120 to 180 dB SPE from all vessels in any stock was 5,515 individuals of the WNP stock of long-beaked common dolphins, represented by an estimated abundance of 279,182 individuals.

Table 4-1. Total Annual and Quarterly Summary of Post-Mission Percentages of Affected Marine Mammal Stocks and Number of Marine Mammals Resulting from 12 LFA Sonar Missions and 47.3 Hours of LFA Sonar Transmissions Conducted by Four SURTASS LFA Sonar Vessels for the LOA Reporting Period 15 August 2012 through 14 August 2013 (Neg = No LFA Sonar Transmissions/Missions; NA = Not Applicable; ESA-listed Marine Mammal Species Highlighted).

			120 to 180 dB SPE										≥180 dB (with Mitigation)	
			Quarter 1 (August to November) All Vessels		Quarter 2 (November to February) All		Quarter 3 (February to May) All Vessels		Quarter 4 (May to August) All Vessels		Annual, All Vessels		Annual, All Vessels	
All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[3]	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected
Blue whale	9,250	CNP	0.0132	2	NA		NA		Neg		0.0132	2	0.0000	0
Bryde's whale	20,501	WNP	0.0320	8	0.0539	13	0.0768	18	Neg		0.1627	39	0.0000	0
Common minke whale	25,049	WNP "O"	0.0973	26	0.1551	41	0.3905	100	Neg		0.6429	167	0.0000	0
Fin whale	9,250	WNP	0.0450	5	0.0406	5	0.0437	5	Neg		0.1293	15	0.0000	0
Humpback whale	1,107	WNP	0.0000	0	0.0071	3	0.0076	1	Neg		0.0147	4	0.0000	0
North Pacific right whale	922	WNP	0.0011	1	NA		0.0031	4	Neg		0.0042	5	0.0000	0
Sei whale	8,600	NP	0.0420	4	NA		NA		Neg		0.0420	4	0.0000	0
Blainville's beaked whale	8,032	WNP	0.1957	16	0.0658	7	0.1019	10	Neg		0.3634	33	0.0000	0
Common bottlenose dolphin	168,791	WNP offshore	0.0125	22	0.0766	130	0.1127	193	Neg		0.2018	345	0.0000	0
Common dolphins	3,286,163	WNP	0.0043	142	0.0267	893	0.0382	1196	Neg		0.0692	2,231	0.0000	0
Cuvier's beaked whale	90,725	WNP	0.0975	90	0.0035	5	0.0334	33	Neg		0.1344	128	0.0000	0
False killer whale	16,668	WNP	0.1003	18	0.2154	37	0.3497	61	Neg		0.6654	116	0.0000	0
Fraser's dolphin	10,226	Hawaii	0.4970	87	NA		NA		Neg		0.4970	87	0.0000	0
Fraser's dolphin	220,789	WNP	0.0086	19	0.0234	53	0.0481	109	Neg		0.0640	144	0.0000	0
Ginkgo-toothed beaked whale	22,799	NP	0.0318	8	0.0232	7	0.0359	10	Neg		0.0909	25	0.0000	0
Killer whale	329	Hawaii	0.5563	2	NA		NA		Neg		0.5610	3	0.0000	0
Killer whale	12,256	WNP	0.0079	1	NA		0.0211	5	Neg		0.0290	5	0.0000	0
Kogia spp.	350,553	WNP	0.0456	161	0.0083	31	0.0236	85	Neg		0.0775	277	0.0000	0
Longman's beaked whale	1,007	CNP	0.5144	6	NA		NA		Neg		0.5144	6	0.0000	0
Melon-headed whale	36,770	WNP	0.1062	40	0.0404	16	0.0656	26	Neg		0.2122	82	0.0000	0
Pacific white-sided dolphin	931,000	WNP	0.0037	35	0.0174	164	0.0286	268	Neg		0.0497	467	0.0000	0
Pantropical spotted dolphin	438,064	WNP	0.062	273	0.0190	85	0.0443	197	Neg		0.1253	555	0.0000	0
Pygmy killer whale	30,214	WNP	0.0216	8	0.0860	27	0.1397	44	Neg		0.2473	79	0.0000	0
Risso's dolphin	83,289	WNP	0.0856	73	0.1885	158	0.3882	326	Neg		0.6623	557	0.0000	0
Rough-toothed dolphin	145,729	WNP	0.0258	38	0.0635	94	0.1299	191	Neg		0.2192	323	0.0000	0
Short-finned pilot whale	53,608	WNP	0.1333	72	0.1113	62	0.4051	219	Neg		0.6497	353	0.0000	0
Sperm whale	102,112	NP	0.0227	24	0.0087	10	0.0346	38	Neg		0.0660	72	0.0000	0
Spinner dolphin	1,015,059	WNP	0.0033	35	0.0002	5	0.0006	9	Neg		0.0041	49	0.0000	0
Striped dolphin	570,038	WNP	0.0276	159	0.0175	102	0.0627	360	Neg		0.1078	621	0.0000	0

Table 4-2. Total Annual and Quarterly Summary of Post-Mission Percentages of Affected Marine Mammal Stocks and Number of Marine Mammals Resulting from Seven LFA and 38.6 Hours of LFA Sonar Transmissions Conducted by Three SURTASS LFA Sonar Vessels for the LOA Reporting Period 15 August 2013 Through 14 August 2014 (ESA-listed Marine Mammal Species Highlighted).

All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[2]	120 to 180 dB SPE										≥180 dB SPE (with Mitigation)	
			Quarter 1 (August to November) All Vessels		Quarter 2 (November to February) All Vessels		Quarter 3 (February to May) All Vessels		Quarter 4 (May to August) All Vessels		Total Annual, All Vessels Combined		Total Annual, All Vessels	
			Percent Stock Affected[3]	Number Animals Affected[4]	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected
Blue whale	9,250	CNP	0.0000	1	0.0003	1	0.0018	1			0.0021	3	0.0000	0
Bryde's whale	20,501	WNP	0.0240	5	0.0085	2	0.0614	14	0.0325	18	0.1264	39	0.0000	0
Common minke whale	25,049	WNP "O"	0.2841	72	0.0473	12	0.3576	92	0.3678	93	1.0568	269	0.0000	0
Fin whale	9,250	WNP	0.0000	0	0.0062	1	0.0774	8	0.0612	6	0.1448	15	0.0000	0
Humpback whale	1,107	WNP	0.0001	1	0.2323	3	1.3692	16			1.6016	20	0.0000	0
North Pacific right whale	922	WNP	0.0000	0	0.0031	1	0.0482	3			0.0513	4	0.0000	0
Western North Pacific gray whale	121	WNP					0.3559	2			0.3559	2	0.0000	0
Blainville's beaked whale	8,032	WNP	0.0395	4	0.0127	2	0.1125	10	0.186	15	0.3507	31	0.0000	0
Common bottlenose dolphin	168,791	WNP offshore	0.0387	66	0.0226	39	0.0218	37			0.0831	142	0.0000	0
Common bottlenose dolphin	105,138	IA					0.0049	6	0.0199	21	0.0248	27	0.0000	0
Cuvier's beaked whale	90,725	WNP	0.0378	35	0.0121	12	0.026	26	0.0099	9	0.0858	82	0.0000	0
False killer whale	16,668	WNP	0.1499	25	0.0457	8	0.0844	15			0.2800	48	0.0000	0
False killer whale	9,777	IA					0.2162	22	0.3028	30	0.5190	52	0.0000	0
Fraser's dolphin	220,789	WNP	0.0305	68	0.0049	11	0.0479	108	0.0505	113	0.1338	300	0.0000	0
Ginkgo-toothed beaked whale	22,799	NP	0.0139	4	0.0045	2	0.0396	10	0.0655	15	0.1235	31	0.0000	0
Killer whale	12,256	WNP	0.0067	1	0.002	1	0.0342	5	0.0205	3	0.0634	10	0.0000	0
Kogia spp.	350,553	WNP	0.0187	66	0.0024	9	0.0206	73	0.0133	48	0.0550	196	0.0000	0
Longman's beaked whale	1,007	CNP	0.2125	3	0.0506	1	1.1563	14	0.7416	8	2.1610	26	0.0000	0
Melon-headed whale	36,770	WNP	0.1008	38	0.0306	12	1.113	411	0.7416	274	1.9860	735	0.0000	0
Pacific white-sided dolphin	931,000	WNP	0.0000	0	0.0035	33	0.0070	66			0.0105	99	0.0000	0
Pantropical spotted dolphin	438,064	WNP	0.0303	133	0.0086	38	0.2387	818	0.3105	681	0.5881	1,670	0.0000	0
Pygmy killer whale	30,214	WNP	0.0599	19	0.0183	6	0.1083	34	0.1644	51	0.3509	110	0.0000	0
Risso's dolphin	83,289	WNP	0.2357	197	0.0337	29	0.1327	111			0.4021	337	0.0000	0
Risso's dolphin	83,289	IA					0.2393	201	0.3428	286	0.5821	487	0.0000	0
Rough-toothed dolphin	145,729	WNP	0.0784	115	0.0106	16	0.0919	135	0.0683	101	0.2492	367	0.0000	0
Short-beaked common dolphin	3,286,163	WNP	0.0119	391	0.0045	148	0.0067	220			0.0231	759	0.0000	0
Short-finned pilot whale	53,608	WNP	0.3629	195	0.0691	38	0.2522	137	0.0792	44	0.7634	414	0.0000	0
Sperm whale	102,112	NP	0.0133	14	0.0031	4	0.0220	23	0.031	33	0.0694	74	0.0000	0
Spinner dolphin	1,015,059	WNP	0.0008	8	0.0002	3	0.0014	16	0.0021	23	0.0045	50	0.0000	0
Striped dolphin	570,038	WNP	0.0559	319	0.0159	91	0.0315	180			0.1033	590	0.0000	0
Striped dolphin	570,038	IA					0.0121	70	0.0268	154	0.0389	224	0.0000	0

Table 4-3. Total Annual and Quarterly Summary of Post-Mission Percentages of Affected Marine Mammal Stocks and Number of Marine Mammals Resulting from 10 LFA sonar missions and 51.6 Hours of LFA Sonar Transmissions Conducted by Four SURTASS LFA Sonar Vessels for the LOA Reporting Period 15 August 2014 Through 14 August 2015 (ESA-listed Marine Mammal Species Highlighted).

All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[3]	120 to 180 dB SPE										≥180 dB (with Mitigation)	
			Quarter 1 (August to November)—All Vessels		Quarter 2 (November to February)—All Vessels		Quarter 3 (February to May)—All Vessels		Quarter 4 (May to August)—All Vessels		Annual Total— All Vessels		Annual Total— All Vessels	
			Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected
Mysticetes														
Blue whale	9,250	CNP	0.0053%	3	0.0005%	1	0.0050%	2			0.0107%	6	0.0000%	0
Bryde's whale	20,501	WNP	0.1012%	23	0.0267%	5	0.0511%	12	0.1764%	40	0.3554%	80	0.0000%	0
Common minke whale	25,049	WNP "O"	0.0981%	26	0.0695%	18	0.4402%	111	0.3346%	84	0.9424%	239	0.0000%	0
Common minke whale	893	WNP "J"							0.9712%	9	0.9712%	9	0.0000%	0
Fin whale	9,250	WNP	0.0047%	1	0.0092%	1	0.1014%	11	0.0131%	14	0.1283%	27	0.0000%	0
Humpback whale	1,107	WNP	0.3311%	6	0.3416%	4	3.6879%	42	0.0148%	1	4.3754%	53	0.0000%	0
North Pacific right whale	922	WNP			0.0046%	1	0.0058%	1	0.0148%	1	0.0252%	3	0.0000%	0
Sei whale	86	NP	0.1401%	13							0.1401%	13	0.0000%	0
Western North Pacific gray whale	121	WNP							0.1143%	1	0.1143%	1	0.0000%	0
Odontocetes														
Blainville's beaked whale	8,032	WNP	0.6195%	52	0.0186%	2	0.0653%	6	0.1293%	12	0.8327%	72	0.0000%	0
Common bottlenose dolphin	168,791	WNP offshore	0.0572%	98	0.0333%	57	0.0650%	110	0.1531%	259	0.3086%	524	0.0000%	0
Common bottlenose dolphin	105,138	IA							0.0016%	2	0.0016%	2	0.0000%	0
Cuvier's beaked whale	90,725	WNP	0.2833%	259	0.0178%	17	0.0569%	53	0.0975%	90	0.4555%	419	0.0000%	0
Dwarf sperm whale	350,553	WNP	0.0867%	304							0.0867%	304	0.0000%	0
False killer whale	16,668	WNP	0.3090%	52	0.0672%	12	0.2446%	42	0.2622%	44	0.8830%	150	0.0000%	0
False killer whale	9,777	IA							0.0694%	7	0.0694%	7	0.0000%	0
Fraser's dolphin	220,789	WNP	0.0059%	14	0.0073%	17	0.0476%	106	0.0394%	88	0.1002%	225	0.0000%	0
Fraser's dolphin	10,226	CNP	1.7309%	177							1.7309%	177	0.0000%	0
Ginkgo-toothed beaked whale	22,799	NP	0.1747%	42	0.0050%	2	0.0230%	6	0.0456%	12	0.2482%	62	0.0000%	0
Killer whale	12,256	WNP	0.0501%	8	0.0009%	1	0.0112%	3	0.0221%	4	0.0843%	16	0.0000%	0
Kogia spp.	350,553	WNP	0.0017%	6	0.0308%	108	0.0288%	102	0.0203%	72	0.0815%	288	0.0000%	0
Longman's beaked whale	1,007	WNP	1.7691%	18	0.0025%	1	0.2846%	4	0.7394%	9	2.7956%	32	0.0000%	0
Melon-headed whale	36,770	WNP	0.0304%	12	0.0425%	16	0.1636%	61	0.2466%	92	0.4832%	181	0.0000%	0
Melon-headed whale	2,450	NMI	0.4605%	170							0.4605%	170	0.0000%	0
Pacific white-sided dolphin	931,000	WNP			0.1181%	1,100	0.0187%	174			0.1367%	1,274	0.0000%	0
Pantropical spotted dolphin	438,064	WNP	0.2348%	1,030	0.0126%	56	0.0472%	208	0.0477%	210	0.3424%	1,504	0.0000%	0
Pantropical spotted dolphin	219,032	IA							0.0239%	53	0.0239%	53	0.0000%	0
Pygmy killer whale	30,214	WNP	0.0365%	12	0.0269%	9	0.0977%	31	0.1076%	33	0.2687%	85	0.0000%	0
Pygmy sperm whale	350,553	WNP	0.0353%	124							0.0353%	124	0.0000%	0
Risso's dolphin	83,289	WNP	0.0941%	80	0.0495%	42	0.3707%	310	0.2510%	210	0.7653%	642	0.0000%	0
Risso's dolphin	83,289	IA							0.0769%	65	0.0769%	65	0.0000%	0
Rough-toothed dolphin	145,729	WNP	0.1126%	166	0.0156%	23	0.1233%	181	0.1060%	156	0.3575%	526	0.0000%	0
Short-beaked common dolphin	3,286,163	WNP			0.0066%	218	0.0178%	585	0.0257%	846	0.0501%	1,649	0.0000%	0
Short-finned pilot whale	53,608	WNP	0.3745%	202	0.1016%	55	0.5542%	298	0.4316%	233	1.4619%	788	0.0000%	0
Sperm whale	102,112	NP	0.0575%	61	0.0046%	5	0.0214%	23	0.0230%	24	0.1065%	113	0.0000%	0
Spinner dolphin	1,015,059	WNP	0.0038%	40	0.0003%	4	0.0012%	14	0.0016%	17	0.0069%	75	0.0000%	0
Striped dolphin	570,038	IA							0.0039%	23	0.0039%	23	0.0000%	0
Striped dolphin	570,038	WNP	0.0547%	314	0.0233%	134	0.0855%	488	0.0881%	502	0.2515%	1,438	0.0000%	0

Table 4-4. Total Annual and Quarterly Summary of Post-Mission Percentages of Affected Marine Mammal Stocks and Number of Marine Mammals Resulting from 13 LFA Sonar Missions and 52.6 Hours of LFA Sonar Transmissions Conducted by Four SURTASS LFA Sonar Vessels for the LOA Reporting Period 15 August 2015 through 14 August 2016 (ESA-Listed Marine Mammal Species Highlighted).

All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[2]	120 to 180 dB SPE										≥180 dB (with Mitigation)	
			Quarter 1 (August to November)—All Vessels		Quarter 2 (November to February)—All Vessels		Quarter 3 (February to May)—All Vessels		Quarter 4 (May to August)—All Vessels		Annual Total— All Vessels		Annual Total— All Vessels	
			Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected
Mysticetes														
Blue whale	9,250	CNP	0.0008%	1	0.0015%	1	0.0008%	1			0.0031%	3	0.0000%	0
Bryde's whale[3]	20,501	WNP	0.0882%	12	0.0857%	10	0.1815%	23	0.1654%	20	0.5208%	65	0.0000%	0
Common minke whale	25,049	WNP "O"	0.2476%	63	0.2405%	61	0.4274%	108	0.3546%	90	1.2701%	322	0.0000%	0
Common minke whale	893	WNP "J"					4.5031%	42	1.8720%	17	6.3751%	59	0.0000%	0
Fin whale	9,250	WNP			0.0296%	3	0.0627%	7	0.0193%	2	0.1116%	12	0.0000%	0
Humpback whale	1,107	WNP	0.5783%	7	1.1010%	13	0.6090%	7			2.2883%	27	0.0000%	0
North Pacific right whale	922	WNP					0.0461%	3			0.0461%	3	0.0000%	0
Western North Pacific gray whale	140	WNP			0.0163%	1	0.0416%	2			0.0579%	3	0.0000%	0
Odontocetes														
Blainville's beaked whale	8,032	WNP	0.0609%	6	0.0390%	4	0.1021%	10	0.0891%	9	0.2911%	29	0.0000%	0
Common bottlenose dolphin	168,791	WNP offshore	0.0673%	115	0.0773%	131	0.0427%	73	0.0914%	156	0.2788%	475	0.0000%	0
Common bottlenose dolphin	105,138	IA					0.0088%	10	0.0045%	5	0.0134%	15	0.0000%	0
Cuvier's beaked whale	90,725	WNP	0.0583%	54	0.0373%	34	0.0249%	24	0.0586%	14	0.1791%	126	0.0000%	0
Deraniyagala beaked whale	22,799	NP					0.0284%	8			0.0284%	8	0.0000%	0
False killer whale	16,668	WNP	0.1483%	26	0.1596%	27	0.0883%	15	0.1467%	46	0.5428%	114	0.0000%	0
False killer whale	9,777	IA					0.1439%	15	0.0654%	8	0.2093%	23	0.0000%	0
Fraser's dolphin	220,789	WNP	0.0272%	61	0.0249%	55	0.0578%	130	0.0458%	98	0.1556%	344	0.0000%	0
Ginkgo-toothed beaked whale	22,799	NP	0.0215%	6	0.0137%	4	0.0360%	10	0.0275%	13	0.0987%	33	0.0000%	0
Killer whale	12,256	WNP	0.0063%	2	0.0067%	1	0.0131%	3	0.1258%	327	0.1519%	333	0.0000%	0
Kogia spp.	350,553	WNP	0.0093%	33	0.0071%	25	0.0101%	36	0.0208%	25	0.0473%	119	0.0000%	0
Long-beaked common dolphin	279,182	WNP	0.3536%	988	0.3336%	932	0.7548%	2,109	0.5638%	1486	2.0057%	5,515	0.0000%	0
Longman's beaked whale	4,571	WNP	0.0535%	4	0.0343%	2	0.0898%	5	0.0725%	41	0.2501%	52	0.0000%	0
Melon-headed whale	36,770	WNP	0.0992%	38	0.1068%	40	0.2066%	77	0.1745%	64	0.5871%	219	0.0000%	0
Pacific white-sided dolphin	931,000	WNP			0.0114%	107	0.0063%	59			0.0178%	166	0.0000%	0
Pantropical spotted dolphin	438,064	WNP	0.0217%	97	0.0276%	122	0.0622%	171	0.0856%	172	0.1972%	562	0.0000%	0
Pygmy killer whale	30,214	WNP	0.0592%	18	0.0637%	20	0.0411%	14	0.0707%	39	0.2348%	91	0.0000%	0
Risso's dolphin	83,289	WNP	0.1299%	109	0.1001%	84	0.0554%	47	0.1585%	119	0.4438%	359	0.0000%	0
Risso's dolphin	83,289	IA					0.1954%	164	0.0843%	72	0.2797%	236	0.0000%	0
Rough-toothed dolphin	145,729	WNP	0.0432%	64	0.0344%	51	0.0324%	49	0.0402%	63	0.1503%	227	0.0000%	0
Short-beaked common dolphin	3,286,163	WNP	0.0416%	480	0.0138%	452	0.0076%	250			0.0630%	1,182	0.0000%	0
Short-finned pilot whale	53,608	WNP	0.2459%	133	0.2315%	125	0.1627%	89	0.1338%	112	0.7739%	459	0.0000%	0
Sperm whale	102,112	NP	0.0097%	11	0.0084%	9	0.0188%	20	0.0137%	15	0.0506%	55	0.0000%	0
Spinner dolphin	1,015,059	WNP	0.0006%	7	0.0007%	8	0.0010%	13	0.0008%	9	0.0032%	37	0.0000%	0
Striped dolphin	570,038	WNP	0.0401%	230	0.0510%	291	0.0282%	161	0.0189%	108	0.1382%	790	0.0000%	0
Striped dolphin	570,038	IA					0.0076%	45	0.0032%	19	0.0108%	64	0.0000%	0

*Bryde's whale take values are inclusive of takes for Bryde's plus Omura's whales.

Table 4-5. Total Annual and Quarterly Summary of Post-Mission Percentages of Affected Marine Mammal Stocks and Number of Marine Mammals Resulting from Two LFA Sonar Missions and 10.8 Hours of LFA Sonar Transmissions Conducted by One SURTASS LFA Sonar Vessel to Date (Quarter 1) for the LOA Reporting Period 15 August 2016 through 14 August 2017 (ESA-Listed Marine Mammal Species Highlighted).

All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[2]	120 to 180 dB SPE										≥180 dB (with Mitigation)	
			Quarter 1 (August to November)—All Vessels		Quarter 2 (November to February)—All Vessels		Quarter 3 (February to May)—All Vessels		Quarter 4 (May to August)—All Vessels		Annual Total— All Vessels		Annual Total— All Vessels	
			Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected	Percent Stock Affected	Number Animals Affected
Mysticetes														
Blue whale	9,250	CNP	0.00055%	1							0.00055%	1	0.00000%	0
Bryde's whale[3]	20,501	WNP	0.02920%	4							0.02920%	4	0.00000%	0
Common minke whale	25,049	WNP "O"	0.00606%	2							0.00606%	2	0.00000%	0
Fin whale	9,250	WNP	0.00063%	1							0.00063%	1	0.00000%	0
Humpback whale	1,328	WNP DPS	0.27700%	5							0.27700%	5	0.00000%	0
Sei whale	7,000	WNP	0.02899%	3							0.02899%	3	0.00000%	0
Odontocetes														
Blainville's beaked whale	8,032	WNP	0.13474%	13							0.13474%	13	0.00000%	0
Common bottlenose dolphin	105,138	WNP	0.00829%	17							0.00829%	17	0.00000%	0
Cuvier's beaked whale	90,725	WNP	0.00982%	11							0.00982%	11	0.00000%	0
Deraniyagala beaked whale	22,799	NP	0.04599%	13							0.04599%	13	0.00000%	0
Dwarf sperm whale	350,553	WNP	0.01735%	72							0.01735%	72	0.00000%	0
False killer whale	16,668	WNP	0.03429%	7							0.03429%	7	0.00000%	0
Fraser's dolphin	16,992	CNP	0.26463%	53							0.26463%	53	0.00000%	0
Ginkgo-toothed beaked whale	22,799	NP	0.04599%	13							0.04599%	13	0.00000%	0
Killer whale	12,256	WNP	0.00608%	1							0.00608%	1	0.00000%	0
Longman's beaked whale	4,571	WNP	0.46120%	25							0.46120%	25	0.00000%	0
Melon-headed whale	2,455	NMI	0.89778%	26							0.89778%	26	0.00000%	0
Pantropical spotted dolphin	438,064	WNP	0.01566%	81							0.01566%	81	0.00000%	0
Pygmy killer whale	30,214	WNP	0.00239%	1							0.00239%	1	0.00000%	0
Pygmy sperm whale	350,553	WNP	0.00707%	29							0.00707%	29	0.00000%	0
Risso's dolphin	83,289	WNP	0.03265%	32							0.03265%	32	0.00000%	0
Rough-toothed dolphin	145,729	WNP	0.01599%	28							0.01599%	28	0.00000%	0
Short-finned pilot whale	53,608	WNP	0.05102%	32							0.05102%	32	0.00000%	0
Sperm whale	102,112	NP	0.00938%	12							0.00938%	12	0.00000%	0
Spinner dolphin	1,015,059	WNP	0.00025%	3							0.00025%	3	0.00000%	0
Striped dolphin	570,038	WNP	0.00328%	22							0.00328%	22	0.00000%	0

*Bryde's whale take values are inclusive of takes for Bryde's plus Omura's whales.

5 MITIGATION EFFECTIVENESS

5.1 EFFECTIVENESS OF EXISTING MITIGATION AND MONITORING MEASURES

LOA Condition 13(f)(iii) requires an analysis of the effectiveness of the mitigation measures associated with the authorized operation of SURTASS LFA sonar with recommendations for improvement, where applicable. During the August 2012 to November 2016 period of the Final MMPA Rule to date for SURTASS LFA sonar, the Navy implemented the required mitigation monitoring measures to minimize, to the greatest extent practicable, adverse impacts to marine mammals.

5.1.1 LFA Mitigation and Buffer Zones

During SURTASS LFA sonar transmissions from August 2012 through November 2016, the radial distance of the LFA mitigation zone or the distance to the 180-dB isopleth, was typically about 1,000 yard (yd) (0.9 km), which in combination with the 1,094 yd (1-km) required buffer zone, resulted in an approximate 2,094 yd (1.9 km) monitoring radius around the LFA sonar vessels and transmitting LFA sonar system. This distance did fluctuate nominally throughout the annual periods with the varying oceanographic and environmental conditions of the mission areas in which LFA sonar operations were conducted.

5.1.2 Visual Monitoring

Throughout the 44 LFA sonar missions conducted between 15 August 2012 and 14 November 2016, 15 visual detections of whales, dolphins, a black fin unidentifiable to species, a sea turtle, and two groups of tuna resulted from efforts of the civilian lookouts onboard the SURTASS LFA sonar vessels. In accordance with the regulations of the Final Rule and annual LOAs, the civilian personnel that are responsible for visual monitoring were trained on the proper methods, procedures, and protocols required to detect and to identify marine mammals or sea turtles and communicate those results up their chain of command. Five visual monitoring trainings were conducted for the visual observer's onboard SURTASS LFA sonar vessels between August 2012 and November 2016.

5.1.3 Passive Acoustic Monitoring

The MILCREW and system engineers monitored the SURTASS passive sonar system for marine mammal vocalizations. Six marine mammal vocalizations were detected on passive sonar within the mitigation/buffer zones during the Final Rule period between August 2012 and November 2016. Three of the six marine mammal vocalizations detected by SURTASS within the mitigation/buffer zones were identified as Bryde's whales. Additionally, 76 passive acoustic detections of marine mammal vocalizations were reported from distances beyond the mitigation/buffer zones for SURTASS LFA sonar. The majority of these detections were identified as Bryde's whales, but fin and humpback whales as well as a possible blue whales were also detected.

Five passive acoustic trainings were conducted since the 2013 to 2014 annual LOA period for the MILCREWs that conduct passive acoustic monitoring as part of their duties as sonar operators onboard the USNS VICTORIOUS, ABLE, EFFECTIVE, and IMPECCABLE during SURTASS LFA sonar missions. Additionally, the MILCREW of the USNS LOYAL, an USNS T-AGOS vessel that is not outfitted with SURTASS LFA sonar, were also trained to increase their ability as sonar operators to distinguish biological sounds from those of mission-directed sounds. During the trainings, the MILCREWs were trained to distinguish between biological and mission-directed sound detections.

This large number of passive acoustic detections and identification to species of the marine mammal vocalizations captured by the SURTASS passive system demonstrated the monitoring capability of the SURTASS system to detect the near and far presence of marine mammals, and more importantly, added valuable distributional information about Bryde's whales occurrence to knowledge of this species in the western North Pacific Ocean.

5.1.4 Active Acoustic Monitoring

The HF/M3 sonar systems were operated continuously during LFA sonar transmissions in accordance with MMPA Final Rule requirements and LOA Conditions 8(e) and 9(c). A total of 51 active acoustic (HF/M3 sonar) detections were reported during the 44 missions of the four SURTASS LFA sonar vessels from August 2012 through November 2016 (Table 2-3). Of the three mitigation monitoring methods used for SURTASS LFA sonar during LFA sonar transmissions, use of the HF/M3 sonar systems resulted in the highest levels of possible marine mammal detection when compared to the number of overall detections, 15 and 6, of visual and passive acoustic monitoring.

The effectiveness of the HF/M3 sonar system to monitor and detect marine mammals has been described in the Navy's 2001 FOEIS/EIS (Chapter 2 and 4) for SURTASS LFA sonar (DoN, 2001) in addition to technical report by Ellison and Stein (1999/2001). The information presented therein remains valid and is incorporated herein by reference. To summarize the effectiveness of the HF/M3 sonar system, the Navy's testing and analysis of the HF/M3 sonar system's capabilities indicated that the system substantially increased the probability of detecting a marine mammal within the LFA mitigation zone and provides a superior monitoring capability especially for medium to large-sized marine mammals to a distance of 1.1 to 1.3 nmi (2 to 2.5 km) from the system (DoN, 2001). Additionally, 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 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 moderately-sized (~33 ft [10 m]) marine mammal swimming towards the system.

5.1.5 Delay/Suspension of LFA Sonar Operations

During the execution of 44 LFA sonar missions to date of the 5-year Final Rule period for SURTASS LFA sonar, in concordance with conditions of the annual LOAs and Final MMPA Rule, LFA sonar transmissions were suspended or delayed a total of 55 times due to the possible detection by marine mammals or sea turtles by visual, passive acoustic, or active acoustic monitoring. About 92 percent of the LFA sonar shutdowns/suspensions were due to HF/M3 detections while the remainder were due to visual detections of marine animals.

5.1.6 Summary of Mitigation Effectiveness

In the 2001 FOEIS/EIS (DoN, 2001), the Navy estimated that the probability of detection for visual and passive acoustic monitoring was low, with predicted probabilities of 9 and 25 percent, respectively. However, detection effectiveness of the active acoustic monitoring (HF/M3) was demonstrated to be 95 percent. When the visual, passive acoustic, and active acoustic mitigation monitoring measures are used together, the predicted effectiveness nears 100 percent within the 180-dB LFA mitigation zone (DoN, 2007). No recent available data alter these conclusions. Hence, the Navy proposes no recommendations for improvements to the mitigation monitoring measures

5.2 New Passive Sonar Technologies as Alternative to SURTASS LFA Sonar

The Navy is required in the FCR to include an analysis of the advancements of passive acoustic technologies and the feasibility of any of these new systems being utilized as a replacement for SURTASS LFA active sonar. Historically (i.e., from the 1940's through about 1990 [USN, 2011]), passive sonars have been the dominant means used by U.S. Naval forces to conduct long-range surveillance of and initial classification of enemy sonar threats. These systems were developed to counter an open ocean threat presented during the Cold War by the former Soviet Union. Passive systems have the benefit of stealth, emitting no noise that may be detected by enemy forces. They were a particularly effective tool against relatively noisy Soviet submarines and allowed effective, accurate tracking at significant distance.

5.2.1 Passive Acoustic Detection of Underwater Threats

Passive sonar technology is dependent on the detection of the noise emitted by an underwater threat. This noise may be created by the movement of a vessel's hull or propellers through water, the sound of a vessel's cooling pumps or other machinery, or of an active sonar pulse produced by the target (Watts, 2003). Under preferable circumstances, passive sonar can be effective at detecting and identifying underwater targets. Certain sound characteristics allow sonar systems to determine the class of ship and/or its speed.

There are, however, a number of significant shortcomings that limit the current and future usefulness of passive sonar. The predominant factor affecting the usefulness of passive sonar, especially in the littoral[3] environment, is the quieting of submarines at the same time ambient noise levels in littoral ocean areas, due principally to the prevalence of commercial ship traffic, have increased markedly (Ort, 2003). Technological advances have reduced the predominant sources of underwater ship noise (i.e., hull flow noise, propeller noise, and propulsion machinery noise) by up to 30 dB between 1960 and 1990 (Tyler, 1992). Toward the end of the Cold War, passive sonars were relying increasingly on 'non-traditional' sound signatures to identify submarine threats (Friedmann, 2004). Since the early 1990s, this trend has continued and with the advent of air-independent propulsion (AIP) systems, perhaps as much as an additional 10 to 20 dB have been reduced from submarine noise signatures.

While passive sonar systems operated effectively against the Cold War submarine threat, the improvements in submarine design and the widespread use of "quieting" technology have reduced their effectiveness (Miasnikov, 1994; Tyler, 1992). Additionally, newer, more advanced diesel-electric submarines are able to remain submerged for longer periods of time while operating with increasing effectiveness. Also, the use of armed underwater drones is a new technology that is rapidly moving from the research and development to operational stages. Most importantly, these smaller drone platforms are even quieter than manned submarines and are, therefore, even harder to detect (Clark, 2015). As the noise generated by underwater vessels such as submarines decreases by half, the difficulty of passive acoustic technologies to detect underwater threats increases ten-fold (Burgess, 2005).

3 The Navy defines "littoral" as the region that horizontally encompasses the land/water mass interface from 50 statute miles (80 km) ashore to 200 nmi (370 km) at sea; this region extends vertically from the seafloor to the top of the atmosphere and from the land surface to the top of the atmosphere (Naval Oceanographic Office, 1999). The Navy's meaning differs from the common definition of littoral because it is based on a tactical, not geographical or environmental, perspective relating to overall coastal operations.

5.2.2 Effectiveness of Passive Sonar Technology in Detecting Underwater Threats

Several papers (Miasnikov, 1994; Ort, 2003; Tyler, 1992) quantitatively address the effectiveness of passive sonars (in an unclassified manner) in light of decreasing submarine noise and increasing littoral ambient noise. Their discussions form the basis of the following brief analysis, which uses the standard passive sonar equation (Urick, 1983):

$$(SL - TL) - (NL - DI) = DT$$

where: SL = source level,

TL = one way transmission loss,

NL = ambient noise level,

DI = directivity index of array, and

DT = detection threshold.

$$SL - NL + DI - DT = TL$$

This equation can be re-arranged to determine the allowable TL for a given set of submarine SLs, ambient noise levels (NL), directivity indexes (DI) and detection thresholds for the passive sonar operators and their equipment (DT). Inherent in this equation is the strong requirement that the "signatures" of the threat submarine be known and understood. This knowledge significantly influences the detection threshold (DT) term of this equation. Essentially, a passive sonar operator needs to know what they are looking for to find it. The quieting of submarine acoustic signatures has adversely affected sonar operator's ability to gather sufficient information on the source level (SL) or detection threshold (DT) (Benedict, 2005). Further complicating this issue is the numerous combinations of submarine platforms now available.

The hypothetical allowable TL levels of 80 and 55, respectively, for a 1960 and a 2006 diesel submarine illustrate the difference in detection ranges currently available compared to those 46 years ago (Table 5-1). This table includes the following reasonable assumptions: 1) the maximum value in a nominal 200 to 300 Hz frequency band is utilized for all SL and NL values, 2) the 1960 submarine had source levels similar to the World War II diesel submarines cited in Urick (1983), 3) the source level for the quieted diesel was conservatively reduced by 40 dB, 4) ambient noise is from the Wenz curves for moderate shipping and 11 to 16 knot wind speed (see Urick, 1983), and for a conservative estimate, no increase is applied for the 2006 value, 5) array DI has improved by 5 dB accounting for improved hydrophones and array design, and 6) DT has improved by 10 dB based on improved signal processing and displays only, and it may be optimistic based on the assumption that the prerequisite submarine signature are known.

By assuming spherical spreading (i.e., 20 log [range]) for the first 1,000 m (3281 ft) and cylindrical spreading (i.e., 10 log [range]) beyond that range, these TLs can be converted into approximate detection ranges for the two sonar sample cases identified here. Based on the information in Table 5-1, 1960 diesel submarine could be detected at a range of approximately 52 nmi (100 km), while the detection range for the 2006 submarine is only 0.5 nmi (0.9 km). Essentially, the 2006 submarine could approach a passive sonar ship close enough to launch torpedoes or missiles, without that ship knowing

Table 5-1. Hypothetical Allowable Transmission Loss Levels for a 1960 And 2006 Diesel Submarine.

Diesel Submarine Examples	Source Level (SL)	Ambient Noise Level (NL)	Directivity Index of Array (DI)	Detection Threshold (DT)	One-Way Transmission Loss (TL)
1960	155	75	15	15	80
2006	115	75	20	5	55

of their presence, while the 1960 sonar system would have detected the submarine long before it was within weapons range. Therefore, by 2006, passive sonar systems alone were not sufficient to meet the new quiet diesel threat. Today, with the inclusion of even quieter and more capable AIP submarines and weapon systems into the scenario, the deficiency of passive sonar systems has continued to increase.

5.2.3 Passive Sonar as Alternative to SURTASS LFA Sonar

Efforts have been made to improve the sensitivity of passive acoustic receivers through the use of more powerful sound processors and improved hydrophone design, which attempt to extract information from even the weakest acoustic signal emanating from an underwater threat. Self-noise, generated by machinery aboard the passive sonar vessel, or by the movement of water around it, greatly affects hull-mounted passive sonar.

This problem of self-noise has been reduced through improved vessel and propeller design, and further combated with the extensive use of passive towed array sonar (PTAS). Since PTAS systems are deployable at a greater distance behind a ship, they are less affected by the ships self-noise (however it is still limited by the ambient noise level). Additionally, PTAS can achieve longer range detection by operating at a lower frequency, where losses from underwater sound propagation are lower. PTAS, however, is subject to a number of disadvantages, including, “being unable to determine the range of a contact, ambiguity in bearing, [and] directional uncertainty because of sideways movement of the array and towing cable” (Watts, 2003). Use of a towed array also affects the minimum water depth and maximum speed at which a towing ship is able to operate.

Some of the problems inherent to PTAS have been addressed by creating an array with two apertures. The SURTASS component of the SURTASS LFA sonar system, for instance, has been modified to a twinline design that is a variant of the basic SURTASS towed array developed for use in shallower water. The twinline PTAS system is a “Y” shaped array with two apertures that are approximately 1/5th the length of a standard SURTASS array. The SURTASS twinline array is designed to provide vertical directivity, resolve right-left ambiguity, and provide higher tow speeds and increased functionality. In testing, use of the twinline array improved detection capabilities in littoral waters by rejecting back-lobe interference in high surface-clutter areas. An additional advancement for PTAS systems is passive synthetic-aperture sonar, which artificially extends the length of the array by making use of the motion of the sensor. This method improves bearing resolution and has been able to detect lower signal levels than previous systems (Ramirez and Krolik, 2016).

Matched-field localization, another emerging technology, seeks to match actual received signals to modeled signals in the hope of determining depth and range. This technology is currently beyond naval capabilities. Among other difficulties, it would be necessary to obtain detailed oceanic environmental data over a large area to generate accurately modeled signals. Many hope that satellite remotely sensing will be able to fulfill this need by providing oceanographic measurements throughout the oceans' depths, but such technology is not yet fully available. Were both these technologies used in combination, they likely would provide a three-dimensional underwater image providing range, bearing, and depth data (Ort, 2003) at much greater ranges than currently are possible.

Last, a more recent development in ASW is the use of cabled passive multi-sensor networks. These proposed systems include either fixed passive acoustic sensors or networks of passive sensors that both function differently than traditional passive systems. Rather than detection and prolonged tracking of underwater threats that is the function of most modern passive acoustic detection systems, these sensors or sensor networks would detect an underwater threat and then send an alert to a non-acoustic platform that would track the threat target, such as a submarine, or that would trigger an active-sonar sensor. Examples of these emerging passive acoustic multi-sensor technologies are the Submarine Hold at Risk (SHARK) and Transformational Reliable Acoustic Path (TRAPs) developed under the auspices of the Defense Advanced Research Programs Agency (Holmes, 2016).

5.2.4 Summary

There are no new passive acoustic technology advancements that currently meet the purpose and need of long-range threat detection (DoN, 2001, 2007, 2012, 2016) of which LFA sonar is capable. Even with the promising advances in PTAS to increase the detection ranges for underwater threats, the ship towing the passive array would still be within the weapons delivery range of a threat submarine. The new fixed underwater multi-sensor networks of passive sensors are not designed to replace active sonar in the detection of underwater threats but are adjuncts to active sonar systems that allow greater expanses of the ocean environment to be surveilled. Based on the continued advancements in submarine quieting techniques, the increased use of autonomous underwater vehicles, and the increase in oceanic ambient noise levels, the present state of passive sonar technology alone cannot detect underwater threats in sufficient time or distance to make an appropriate response possible.

6 ASSESSMENT OF LONG-TERM EFFECTS AND ESTIMATED CUMULATIVE IMPACTS

The Navy's conclusion that its operation of SURTASS LFA sonar had a negligible impact on affected marine mammal stocks or species of marine mammals in the western North Pacific Ocean during the period covered in this FCR is consistent with previous assessments of its impacts on regional stocks of marine mammals. Likewise, the Navy's assessment of the long-term effects and estimated cumulative impacts from employment of SURTASS LFA sonar has not changed from previous conclusions. That is, cumulative impacts from the operation of up to four SURTASS LFA sonar systems are not a reasonably foreseeable significant adverse impact on marine mammals.

The greatest cumulative impact associated with the employment of SURTASS LFA sonar in combination with other known current or planned maritime activities is the increase in the ambient noise environment, whether on a transient basis from sonar and seismic sound transmissions or a more persistent basis from ship traffic. The operation of four SURTASS LFA sonar systems do not add appreciably to the underwater ambient noise environment in the 100 to 500 Hz frequency band to which marine mammal stocks are exposed, and the impact on the overall noise levels in the ocean is minimal. This is because SURTASS LFA sonar systems are active or transmitting for such a small amount of overall time (i.e., no more than a 20 percent duty cycle, which means that the sonar is off and not transmitting for 80 percent of the time) during a mission and for such a small percentage of an annual period. The Navy is permitted a total of 1,728 hours of LFA sonar transmit time for all four SURTASS LFA sonar vessels per annual LOA period, but much less than that amount was transmitted for all four SURTASS LFA sonar vessels from August 2012 through November 2016. In most of the ocean, the 10 to 500 Hz portion of the ambient noise spectrum is dominated by anthropogenic noise sources, particularly from shipping and seismic exploration (airguns). Commercial shipping is the most common source of LF noise in the ocean and its impact on the ambient noise environment is basin-wide (Hildebrand, 2009). Although seismic exploration is not extensive in the western North Pacific Ocean, commercial maritime traffic is very extensive, particularly in the continental seas along the Asian coast.

Although the total number of sea-going commercial ships around the world is difficult to quantify, both the carrying capacity and number of ships has increased significantly over the last several decades. Tournadre (2014) estimated that between 1992 and 2002, maritime ship traffic increased by 60 percent, averaging about 6 percent per year, with the largest increases in maritime traffic occurring in the Indian Ocean and South China and East China seas. If the Navy were to operate its SURTASS LFA sonar systems at the fully permitted level of 1,728 hr per year and at an 20 percent duty cycle, the contribution to the LF ambient noise environment from the operation of LFA sonar would be comparable to the noise generated by approximately 22 million ship-days per year by the world's commercial shipping industry (Hildebrand, 2005). Considering the total acoustic energy output of individual sources in calculating an annual noise energy budget in energy units of Joules, commercial supertankers were estimated to contribute 3.7×10^{12} Joules of acoustic energy into the marine environment each year (Joules/year [yr]); seismic airguns were estimated to contribute 3.9×10^{13} Joules/yr; mid-frequency military sonar was estimated to contribute 2.6×10^{13} Joules/yr; and each LFA sonar vessel operating at 432 hr/yr was estimated to contribute 1.7×10^{11} Joules/yr (Hildebrand, 2005). The percentage of the total anthropogenic acoustic energy budget added by each LFA source is estimated to be 0.25 percent when these anthropogenic sources are considered together (Hildebrand, 2005). Therefore, within the existing

ocean environment, the potential for accumulation of noise due to the intermittent operation of SURTASS LFA sonar is considered negligible (DoN, 2012). Further, the potential impacts associated with the combined LF sound generated by LFA sonar, seismic exploration, and shipping are most likely to be behavioral in nature, likely to be temporary effects, 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 marine mammal stocks and species likely to be exposed either annually or in the reasonably foreseeable future.

7 CONCLUSIONS

The Navy considers that it has met all of the requirements of the MMPA Final Rule and annual LOAs, as issued, for the operation of SURTASS LFA sonar. These requirements include all mitigation, monitoring, and reporting requirements, and timely applications for renewal of annual LOAs. In addition, this FCR is required to provide an analysis of all monitoring and research conducted during the period of these regulations, an estimate of cumulative impacts on marine mammal stocks, and an analysis on the advancement of alternative (passive) technologies as a replacement for LFA sonar. This report additionally provides an unclassified summary and analysis of SURTASS LFA sonar operations conducted by the USNS VICTORIOUS, USNS ABLE, USNS EFFECTIVE, and USNS IMPECCABLE from August 2012 through November 2016.

As previously documented in the quarterly and annual reports for SURTASS LFA sonar, post-operational incidental harassment assessments showed that no estimated harassment of marine mammals occurred at RLs at or above 180 dB. The post-operational estimates of the percentage of marine mammal stocks exposed to LFA sonar transmissions between 120 and 180 dB SPE were below, in most cases well below, the maximum 12 percent annually authorized in the current Rule and LOAs for any affected marine mammal stock. Indeed, the highest percentage annual takes of any affected stock at Level B harassment over the August 2012 to November 2016 period was 6.4 percent (Table 4-4).

An evaluation of mitigation effectiveness demonstrated that the overall effectiveness exceeded the original estimates. Visual and LF passive acoustic monitoring showed low probability of detection as predicted, but the effectiveness of active acoustic monitoring (HF/M3 sonar) proved to be consistent with the values in the FOEIS/EIS (DoN, 2001). As part of the assessment of new passive sonar technologies, the purpose and need as stated in the environmental compliance documentation for SURTASS LFA sonar to date (DoN, 2001, 2007, 2012, 2015, and 2016) remain valid. Passive sonar alone cannot meet the need to detect submarines in a threat environment in which submarines are becoming quieter and ambient oceanic noise levels are increasing. Presently, there are no advancements in passive acoustic technologies that even approach the level of detection provided by SURTASS LFA sonar.

SURTASS LFA transmissions have not contributed significantly to an overall increase in anthropogenic oceanic noise levels and have not caused any known injury or mortality. Therefore, it is logical to assume that cumulative effects from intermittent LFA sonar transmissions are not a reasonably foreseeable significant adverse impact to marine mammal stocks or species.

In conclusion, the operation of the SURTASS LFA sonar systems, with appropriate mitigation measures, have caused no measurable environmental effects in the oceanic areas in which LFA sonar missions have been conducted over the period covered in this report. As such, the Navy believes that the continuation of SURTASS LFA sonar operations will not result in adverse impacts to marine mammal stocks or species and that all measures to ensure the least practicable adverse impact to marine mammal stocks or species are being conducted whenever SURTASS LFA sonar is transmitting.

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