2017 TO 2018 ANNUAL REPORT FOR SURVEILLANCE TOWED ARRAY SENSOR SYSTEM LOW FREQUENCY ACTIVE (SURTASS LFA) SONAR ACTIVITIES

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL OPERATIONS

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ACRONYMS AND ABBREVIATIONS

µ	micro
ABR	auditory brainstem response
AEP	auditory evoked potential
CEE	controlled exposure experiment
CFLA	compact low frequency active
CFR	Code of Federal Regulations
CLFA	Compact Low Frequency Active
CNO	Chief of Naval Operations
CNP	Central North Pacific
dB	decibel(s)
dB re 1 µPa @ 1 m	decibel(s) relative to one microPascal at one meter from center of acoustic source
DoN	Department of the Navy
DPS	distinct population segment
ft	foot/feet
HARP	high-frequency acoustic recording package
HF	high frequency
HF/M3	High Frequency Marine Mammal Monitoring (sonar)
HLA	horizontal line array
hr	hour(s)
Hz	Hertz
IA	Inshore Archipelago
ITS	incidental take statement
km	kilometer(s)
kph	kilometer(s) per hour
kt	knot(s)
LF	low frequency
LFA	Low Frequency Active
m	meter(s)
M3	Marine Mammal Monitoring
MMPA	Marine Mammal Protection Act
NDE	National Defense Exemption
NEPA	National Environmental Policy Act
nmi	nautical mile(s)
NMFS	National Marine Fisheries Service
NP	North Pacific
OBIA	Offshore Biologically Important Area
OEIS	Overseas Environmental Impact Statement
Pa	Pascal
RL	received level
rms	root mean square
ROD	Record of Decision
sec	second(s)

SEIS/SOEIS	Supplemental Environmental Impact Statement/Supplemental Overseas Environmental Impact Statement
SEL	sound exposure level
SL	source level
SPE	single ping equivalent
SPL	sound pressure level
SURTASS	Surveillance Towed Array Sensor System
T-AGOS	Tactical Auxiliary General Ocean Surveillance (vessel)
TTS	temporary threshold shift
U.S.	United States of America
U.S.C.	United States Code
USNS	United States Naval Ship
WNP	Western North Pacific
yx	yard(s)
yr	year(s)

1 INTRODUCTION

On August 10, 2017, after conferring with the Secretary of Commerce and pursuant to Title 16, Section 1371(f) U.S. Code (U.S.C.), the Secretary of Defense determined that it was necessary for the national defense to exempt all military readiness activities that employ Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) and Compact LFA sonar (CLFA) (collectively hereafter, SURTASS LFA) sonar from compliance with the requirements of the Marine Mammal Protection Act (MMPA) for two years from August 13, 2017 through August 12, 2019, or until such time when the National Marine Fisheries Service (NMFS) issues the required regulations and Letters of Authorization (LOAs) under Title 16, Section 1371, whichever is earlier. During this exemption period, all military readiness activities that involve the use of SURTASS LFA sonar are required to comply with all mitigation, monitoring, and reporting measures set forth in the 2017 National Defense Exemption (NDE) for SURTASS LFA sonar (hereafter, NDE) (Appendix A).

Under the 2017 NDE, the United States (U.S.) Navy is approved to conduct military readiness activities using SURTASS LFA sonar in the western and central North Pacific Ocean and eastern Indian Ocean onboard four ocean surveillance ships: the U.S. Naval Ship (USNS) VICTORIOUS (Tactical Auxiliary General Ocean Surveillance [T-AGOS] 19), USNS ABLE (T-AGOS 20), USNS EFFECTIVE (T-AGOS 21), and USNS IMPECCABLE (T-AGOS 23). The sonar sound signals transmitted by the four SURTASS LFA sonar systems are to range between the frequencies of 100 and 500 Hertz (Hz) with the source level (SL) of each of the 18 sonar array projectors transmitting no more than 215 decibels (dB) relative to 1 micro Pascal at 1 meter (m) (dB re 1 µPa @ 1 m) (root mean square [rms]) at a maximum duty cycle of 20 percent. During the August 2017 to August 2018 period, LFA sonar transmissions by each of the four ocean surveillance ships must not exceed 255 hours (hr).

The Navy is also approved to conduct military readiness activities using SURTASS LFA sonar in 15 geographic areas of the western and central North Pacific and eastern Indian oceans (Table 1; Figure 1) and to take marine mammals in these areas by Level B incidental harassment under the MMPA. However, during the annual period, Level B incidental harassment cannot exceed 12 percent of any marine mammal stock from exposure to all SURTASS LFA sonar transmissions. During LFA sonar transmissions, the Navy must conduct visual, passive acoustic (using the SURTASS array), and active acoustic (using the high frequency marine mammal monitoring [HF/M3] sonar) monitoring of the mitigation and buffer zones surrounding the LFA sonar array for the presence of protected marine animals (principally marine mammals and turtles).

One of the NDE requirements for SURTASS LFA sonar activities is the submittal of an unclassified, annual report that at a minimum summarizes the quarterly unclassified mission reports, provides estimates of the percentage of marine mammal stocks affected by the activities using SURTASS LFA sonar during the annual period, an analysis of the mitigation measures employed during the quarterly missions, the effectiveness of the mitigation to minimize or eliminate harassment to marine mammals, and an assessment of the long-term and cumulative effects of the military readiness activities using SURTASS LFA sonar. Accordingly, this annual report summarizes the Navy's military readiness activities using SURTASS LFA sonar in the western North Pacific Ocean from 13 August 2017 through 12 August 2018.

Table 1. Fifteen Nominal Mission and Modeling Areas for SURTASS LFA Sonar in the Western and Central North Pacific and Eastern Indian Ocean.

Mission/Model Area Number	*SURTASS LFA Mission/Model 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

1.1 2017 TO 2018 SUMMARY OF SURTASS LFA SONAR ACTIVITY

This annual report is the unclassified summary of the Navy's SURTASS LFA sonar activities for the NDE period from 13 August 2017 through 12 August 2018 for the USNS VICTORIOUS, USNS ABLE, USNS EFFECTIVE, and USNS IMPECCABLE, as reported in the 16 quarterly mission summary reports submitted to NMFS. During this 2017 to 2018 NDE annual period, the Navy conducted a total of three at-sea missions using LFA sonar in the western North Pacific Ocean that had a combined duration of 11.5 days with LFA sonar transmissions totaling 23 hr (Table 2), which is less than the approved number of sonar transmit hours for all vessels. Per mitigation monitoring protocol for SURTASS LFA sonar, during the Navy's three SURTASS LFA sonar missions, LFA sonar transmissions were suspended/delayed twice due to the detection by active acoustic monitoring of possible marine mammals or sea turtles. No visual or passive acoustic detections of marine animals were made during the three SURTASS LFA sonar missions in the mitigation/buffer zones. No at-sea missions were conducted by SURTASS LFA sonar vessels during Quarter 1 of the annual NDE period. Also, no at-sea missions nor LFA sonar transmissions were executed by the USNS EFFECTIVE during the annual period.

During some SURTASS LFA sonar missions, LFA sonar transmissions may be suspended or delayed for reasons totally unrelated to mitigation monitoring. Also, while no passive acoustic detections of

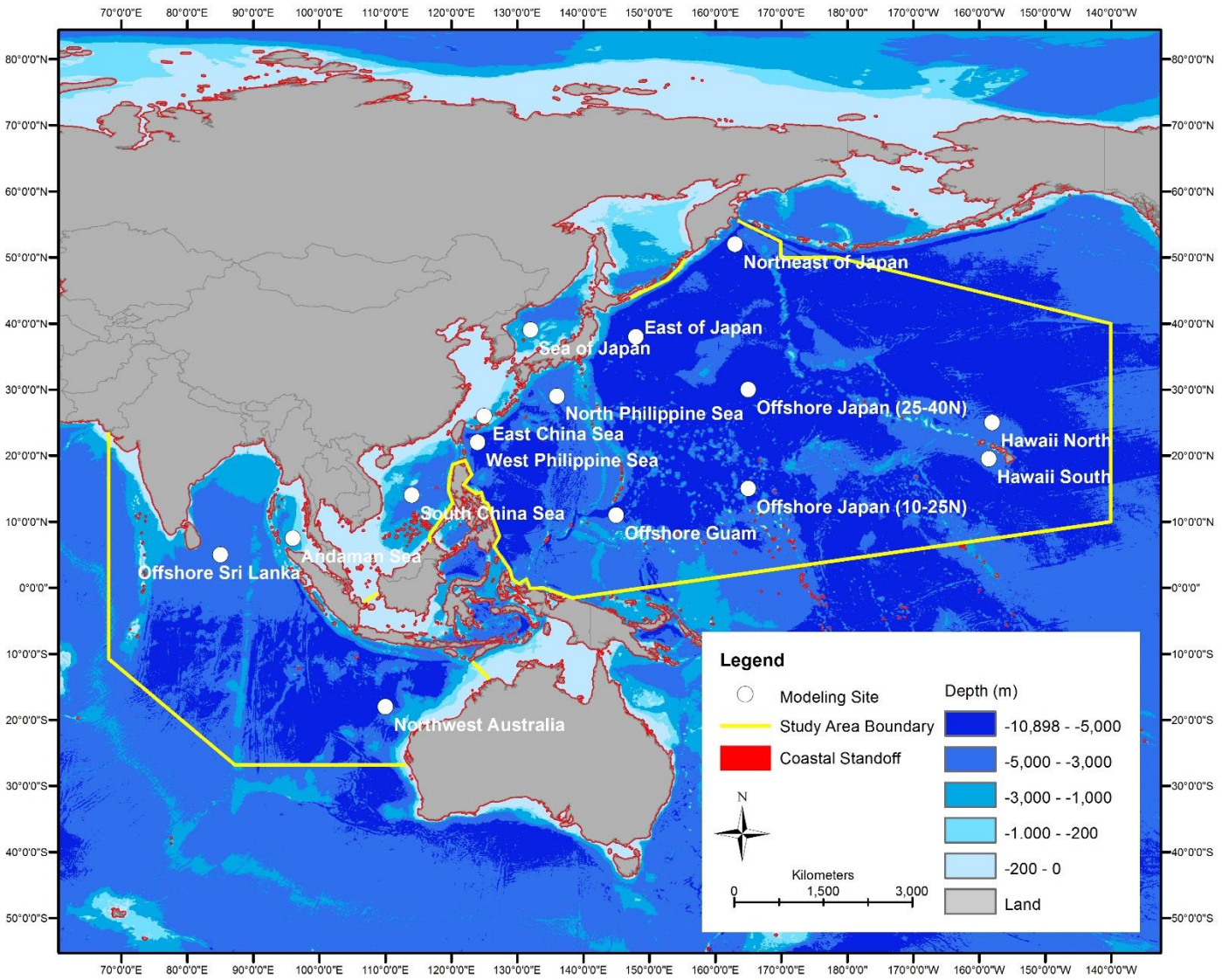

Figure 1. Study Area for Military Readiness Activities Using SURTASS LFA Sonar and the Locations of the 15 Representative Mission/Modeling Areas in the Western and Central Pacific and Eastern Indian Oceans.

Table 2. Summary of the Military Readiness Activities Using SURTASS LFA Sonar from August 2017 to August 2018 Including Results of Mitigation Monitoring.

SURTASS LFA Sonar Vessel	*Number of Missions*	*Mission Days*	*LFA Sonar Transmit Hours (hr)*	*Visual Monitoring Detections*	*Active Acoustic (HF/M3) Detections*	*Passive Acoustic Detections*	*LFA Sonar Shutdowns/ Suspensions*
USNS VICTORIOUS (T-AGOS 19)	1	1.73	4.59	0	1	0	1
USNS ABLE (T-AGOS 20)	1	1.8	6.02	0	1	0	1
USNS EFFECTIVE (T-AGOS 21)	0	0	0	0	0	0	0
USNS IMPECCABLE (T-AGOS 23)	1	7.93	12.39	0	0	0	0
Total	3	11.46	23.0	0	2	0	2

vocalizing marine mammals were made within the mitigation or buffer zones for SURTASS LFA sonar, three passive acoustic detections of marine mammals were made during the three missions but were evaluated to be outside the mitigation/buffer zones; thus, these three passive acoustic detections did not result in suspensions or delays of LFA sonar transmissions.

1.1.1 USNS VICTORIOUS (T-AGOS 19)

The USNS VICTORIOUS conducted one SURTASS LFA sonar mission encompassing 1.7 days in the second quarter of the annual period during which LFA sonar was transmitted for a total of 4.6 hr (Table 2). During the USNS VICTORIOUS' mission, no visual, no passive acoustic, and one active acoustic detection of marine animals were reported within the LFA sonar mitigation and buffer zones. As a result of the one HF/M3 detection, LFA sonar transmissions were suspended/delayed once during the mission.

Although no passive acoustic detections were made within the LFA mitigation or buffer zones during the VICTORIOUS' mission, passive acoustic detections of marine mammal vocalizations were made that were evaluated to be beyond the extent of the mitigation/buffer zones for SURTASS LFA sonar. Vocalizations of as many as four humpback whales were detected and tracked over a long duration that began on the same date the VICTORIOUS' mission commenced. Since these marine mammal vocalizations were judged to be farther away than the mitigation monitoring distance, no suspensions or delays of LFA sonar were required in association with these passive acoustic detections, per mitigation monitoring protocol.

During Quarters 1, 3, and 4, the USNS VICTORIOUS conducted no at-sea LFA sonar missions nor transmitted any LFA sonar signals (Appendix Table B-1). Accordingly, three reports of negative activity for the VICTORIOUS were submitted to NMFS for these respective quarters.

1.1.2 USNS ABLE (T-AGOS 20)

One at-sea mission lasting 1.8 days was conducted by the USNS ABLE during the third quarter of the annual 2017 to 2018 NDE period with LFA sonar signals transmitted for 6 hr (Table 2). During the ABLE's one mission, no visual or passive acoustic detections of possible marine animals were made, but two active acoustic (HF/M3) detections of marine animals were reported within the LFA sonar mitigation and buffer zones. Due to the HF/M3 detections, LFA sonar transmissions were suspended/delayed twice, per mitigation/monitoring protocol. In Quarters 1, 2, and 4, the USNS ABLE conducted no at-sea LFA sonar missions and transmitted no LFA sonar (Appendix Table B-2). Consequently, the Navy submitted three reports of negative activity to NMFS for these quarters.

1.1.3 USNS EFFECTIVE (T-AGOS 21)

The USNS EFFECTIVE conducted no at-sea LFA sonar missions and transmitted no LFA sonar during the annual period (Appendix Table B-3). Four negative activity reports for the EFFECTIVE were submitted to NMFS by the Navy during the annual period.

1.1.4 USNS IMPECCABLE (T-AGOS 23)

During the fourth quarter of the August 2017 to August 2018 NDE annual period, the USNS IMPECCABLE conducted one at-sea mission over 7.9 days during which LFA sonar was transmitted for 12.4 hr (Table 2). No visual, passive acoustic, or active acoustic detections of possible marine animals were made in the mitigation/buffer zones during the IMPECCABLE's fourth quarter mission. Subsequently, in accordance

with mitigation monitoring protocol, LFA sonar transmissions were not suspended/delayed during the mission.

However, during the IMPECCABLE's fourth quarter at-sea mission, two passive acoustic detections of vocalizing marine mammals were reported outside the LFA sonar mitigation and buffer zones during the execution of the IMPECCABLE's mission. Both passive acoustic detections were identified as Bryde's whales. In relation to the USNS IMPECCABLE, the first Bryde's whale was detected with a bearing of 142T while the second Bryde's whale detection was detected with a bearing of 090T.

During the first three quarters of the annual period, the USNS IMPECCABLE conducted no at-sea LFA sonar missions nor transmitted any LFA sonar (Appendix Table B-4). Negative activity reports for the IMPECCABLE were submitted to NMFS for these quarters.

2 SUMMARY OF 2017 TO 2018 MITIGATION, MONITORING, AND REPORTING

Per mitigation and monitoring protocols for SURTASS LFA sonar as detailed in the 2017 NDE, during the 23 hr of the 2017 to 2018 LFA sonar transmissions, visual, passive acoustic, and active acoustic monitoring were conducted by civilian and military personnel aboard the USNS VICTORIOUS, ABLE, and IMPECCABLE. Two HF/M3 active acoustic detections resulted in two suspensions/delays of LFA sonar transmissions. All other mitigation and monitoring activities were conducted per the protocol outlined in the NDE, including ramp-up of the HF/M3 sonar system prior to its use for monitoring, by designated and qualified civilian and military personnel.

The Navy maintained a running total of the estimated takes associated with the quarterly and annual LFA sonar transmit hours of all SURTASS LFA sonar vessels to ensure that no more than 12 percent of any marine mammal species or stock would be taken by MMPA Level B harassment annually. For the August 2017 to 2018 annual period, the highest percentage of any marine mammal stock experiencing Level B harassment from exposure to the 23 hr of LFA sonar transmissions was 5.4 percent of the Western North Pacific (WNP) stock and distinct population segment (DPS) of humpback whales (Table 3). This percentage of Level B harassment for the WNP stock/DPS of humpback whales equated to 73 individual whales taken over the entire annual period.

The Navy submitted unclassified reports (or enclosures) per quarter for each SURTASS LFA sonar vessel, regardless of whether any military readiness activities using SURTASS LFA sonar were conducted that quarter. Thirteen negative activity reports were submitted to NMFS for those quarters when no military readiness activities were conducted using SURTASS LFA sonar by one of the four SURTASS LFA sonar vessels. Three classified quarterly reports with associated unclassified summary enclosures were submitted for each of the three at-sea missions conducted during the annual NDE period. Status of additional monitoring and reporting requirements follows.

2.1 MITIGATION EFFECTIVENESS

NDE Condition IV2(c) requires the Navy analyze and report on the mitigation effectiveness for SURTASS LFA sonar with recommendations for improvement, where applicable. Although the hours of LFA sonar transmissions during the annual period were low, implementation of the required mitigation and monitoring measures were conducted according to the protocol outlined in the NDE and proved to be effective in detecting two possible sea turtles or marine mammals, with the subsequent suspension of LFA sonar transmissions to prevent exposure above 180 dB. The low number or lack of monitoring detections reported during the annual period can be associated directly with the low number of LFA

sonar transmit hours rather than the efficacy of the three monitoring methods, since mitigation monitoring only is conducted when LFA sonar is actually transmitting.

Although visual monitoring of the sea surface surrounding the SURTASS LFA sonar vessels was conducted during daylight hours during the three missions when LFA sonar was transmitting, no visual detections of marine mammals or sea turtles were made. Visual monitoring of the LFA sonar mitigation zone is only effective during daylight hours, in low sea states, and during good weather. Given these stipulations, the mitigation effectiveness of visual monitoring for marine mammals or sea turtles is estimated to have an effectiveness of about 9 percent (DoN, 2001).

When LFA sonar was transmitting, the military sonar operators monitored the SURTASS passive sonar system for the detection of marine mammal vocalizations. No marine mammal vocalizations were detected on passive sonar within the mitigation/buffer zones during the three at-sea missions. However, vocalizing marine mammals were detected but were evaluated to be at a range beyond the extent of the mitigation plus buffer zones. During the USNS VICTORIOUS' second quarter mission, vocalizations of as many as four humpback whales were detected and tracked over a long duration. Similarly, during the USNS IMPECCABLE's fourth quarter at-sea mission using LFA sonar, vocalizations of two Bryde's whales were detected. These passive acoustic detections and identification to species of the marine mammal vocalizations captured by the SURTASS passive system demonstrated the efficacy of the system to detect vocalizing marine mammals, even when the whales are located at a distance beyond which visual and active acoustic monitoring cannot detect the presence of marine mammals.

The HF/M3 sonar systems were operated continuously during LFA sonar transmissions in accordance with stipulations of the NDE. Two active acoustic (HF/M3 sonar) detections were reported during two of the three missions conducted using LFA sonar during the 2017 to 2018 period; no other detections of possible marine animals occurred due to visual or passive acoustic monitoring of the mitigation and buffer zones.

The effectiveness of the HF/M3 sonar system to monitor and detect marine mammals using active acoustics has been described in the Navy's 2001 FOEIS/EIS (Chapters 2 and 4) for SURTASS LFA sonar (DoN, 2001) in addition to the technical report by Ellison and Stein (2001). 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 detecting medium- to large-sized cetaceans at a distance of 1.1 to 1.3 nmi (2 to 2.5 km) from the HF/M3 sonar system (DoN, 2001). The LFA mitigation zone is the distance to the 180-dB isopleth while the buffer zone imposed by NMFS is an additional 0.54 nmi (1 km).

Additionally, qualitative and quantitative assessments of the HF/M3 sonar system's ability to detect marine mammals of various sizes were verified in 170 hr of at-sea testing. The sea tests demonstrated that several detections of cetaceans by the HF/M3 sonar system would occur before the cetacean entered the LFA mitigation zone (DoN, 2001). Indeed, based on the scan rate of the HF/M3 sonar system, most marine mammals would receive at least 8 pings from the sonar (i.e., 8 sonar returns or detections) before even entering the LFA mitigation zone. Based on this, the probability of a marine mammal being detected prior to entering the LFA mitigation zone approaches 100 percent (Ellison and Stein, 2001). The probability of the HF/M3 sonar system detecting a medium- to large-sized (~33 to 98 ft [10 to 30 m]) cetacean swimming towards the system in the LFA mitigation zone with only one HF/M3 ping would be near 100 percent (Ellison and Stein, 2001). During sea tests of the HF/M3 sonar system

with trained Navy bottlenose dolphins, the detection rate of the dolphins was about 80 percent, but analysts noted that in more normal at-sea operational conditions with reduced clutter interference and with dolphins traveling more typically in pods rather than singly, the detection rate would be higher (Ellison and Stein, 2001).

In examining the results of the mitigation monitoring during this annual reporting period, particularly given the low number of LFA sonar transmit hours in which these monitoring measures were employed, and the results of the previous sixteen years of SURTASS LFA sonar use, the Navy has concluded that the mitigation measures and monitoring have been implemented properly, and accordingly, have successfully minimized the potential adverse effects of SURTASS LFA sonar to marine mammals to the greatest extent practicable. This conclusion is supported by documentation that no known mortality or injury to marine mammals has occurred over this period in association with use of SURTASS LFA sonar. The Navy will continue its commitment to training the crews of the SURTASS LFA sonar vessels in the proper and effective implementation of the mitigation protocols but recommends no additional mitigation measures to be necessary.

2.2 ANNUAL TRAINING

2.2.1 Visual Observer Training

Trainings of the civilian crew members designated as lookouts onboard two SURTASS LFA sonar vessels were conducted during the annual NDE period. In January 2018, a marine mammal biologist qualified in conducting at-sea marine mammal visual monitoring from surface ships trained the civilian bridge crews of the USNS IMPECCABLE and the USNS VICTORIOUS when these vessels were in port. These crew members are responsible for visual monitoring of the sea surface when SURTASS LFA sonar is transmitting as well as during normal ship operations. Sixteen crew members from the two SURTASS LFA sonar vessels participated in the trainings. The majority of these civilian crew members had never worked aboard a SURTASS LFA sonar vessel previously and were unaware of the specifics of visual mitigation monitoring.

The visual observer training consists of two components: 1) an observation component that covers the visual monitoring requirements specified under the NDE and ESA permit for LFA sonar use as well as fundamentals of at-sea visual monitoring of marine mammals and sea turtles; and 2) an identification component that includes an overview of the types of marine mammals and sea turtles as well as the key observable features used to identify the potentially occurring marine mammal and sea turtle species that may be encountered in the ocean areas where SURTASS LFA sonar is used. A visual monitoring training manual that includes electronic versions of the LFA sonar-specific training as well as the Navy's Marine Species Awareness Training video and marine mammal field guides are provided and retained onboard all SURTASS LFA sonar vessels.

2.2.2 Passive Acoustic Training

One of the mitigation monitoring conditions of the NDE and ESA permit requires the Navy to use the passive SURTASS array to monitor for vocalizing cetaceans. To ensure that the military crew sonar operators are capable of detecting and differentiating marine mammal vocalizations from other biological and natural sound signals received by the SURTASS array, the Navy authorized passive acoustic trainings to be conducted by marine acousticians experienced in identifying and classifying marine mammal vocalization signals. During the August 2017 to August 2018 annual period, two passive

acoustic trainings were conducted by Marine Mammal Monitoring (M3) Program acousticians for the military crews responsible for conducting 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 military crew of the USNS LOYAL, an USNS T-AGOS vessel outfitted only with the SURTASS system, was also trained to increase their ability as sonar operators to distinguish biological sounds from mission-directed sounds. The military crew members were trained over two days in September 2017 and two days in March 2018 at the Naval Ocean Processing Facility (NOPF) Whidbey Island, Washington.

The passive acoustic trainings consist of classified components that covers the following: 1) the requirements of passive acoustic monitoring for marine mammals specified under permits or the NDE for SURTASS LFA sonar use; 2) marine mammal identification describing basic information about the primary marine mammal species they may detected with the SURTASS system and species-specific characteristics for visual identification on spectrograms during passive acoustic monitoring; and 3) recommended sonar display parameters to facilitate the detection and identification of marine mammal species. Reference materials of marine mammal acoustic signatures, including the 75-page manual, *Tactical Identification Guide for SURTASS LFA Sonar Analysts,* and copies of the training components have been made available to the sonar operators.

2.3 Consideration of Monitoring or Research on the Potential Effects of SURTASS LFA Sonar on Beaked Whales and/or Harbor Porpoises

To assess the potential for effects to beaked whale species and harbor porpoises from exposure to SURTASS LFA sonar, the Navy convened a Scientific Advisory Group (SAG) of recognized scientific subject matter experts to identify feasible monitoring and/or research options the Navy could potentially implement. The SAG recommendations were independent scientific findings that are accessible to the public on the SURTASS LFA sonar website (http://www.surtass-lfa-eis.com). The Navy also convened an Executive Oversight Group (EOG) to evaluate the SAG recommendations in relation to existing Navy research programs and available Navy research funding and needs. The EOG provided 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.

The possible research-monitoring studies of effects on beaked whales and harbor porpoises were ranked (from highest to lowest potential) and divided into three categories according to the estimated cost of the proposed research efforts: those research efforts estimated to be fairly minimal in cost (less than $100,000); those moderately costly research efforts estimated from $100,000 to $500,000; and costly research estimated at $500,000 and above.

1. Research efforts estimated to cost less than $100,000:

    - Review existing data collected from already deployed high-frequency acoustic recording package (HARP) sensors to determine spatiotemporal overlap with SURTASS LFA sonar missions and the presence of beaked whales. Pacific government and institutional researchers were contacted by NMFS regarding HARP deployments in the North Pacific Ocean and the potential for accessing their compiled data. Additionally, Baumann-Pickering et al. (2014) published the results of over eleven cumulative years of HARP deployments in the North Pacific, some in areas that may overlap with areas where SURTASS LFA sonar missions may be conducted. A research effort to define the spatiotemporal overlap of HARP deployments and potentially beaked whale

recordings in conjunction with the locations of LFA sonar missions is estimated to require minimal cost. If geospatial overlap exists with HARP deployment and SURTASS LFA sonar locations, the cost for data analysis would depend on the extent of the overlap.

2. Research efforts estimated to cost between $100,000 and $500,000 but for which methodologies exist and implementation could extend existing studies:

   - Targeted deployment of one HARP sensor for one year in the western North Pacific Ocean in a location where SURTASS LFA sonar missions have historically occurred. The estimated cost of such a deployment is $250,000. The objective of this study would be to document beaked whale vocal behavior before, during, and after LFA sonar transmissions. Careful consideration of lessons learned from previous deployments would be needed to increase the probability of a successful project.

   - Anatomical modeling of LF sound reception by beaked whales, with an approximate cost estimated between $150,000 and $200,000. Since the EOG meetings in 2014, Cranford and Krysl (2015) presented a synthetic, predicted audiogram of a fin whale, based predominantly on bone conduction of sound through the head to the ear. NMFS (2018) noted that the predicted audiogram does not match the typical U-shaped audiogram expected with normal hearing in mammals in that there is "hump" at low frequencies and shallow roll-off of sensitivity at high frequencies. Given these difficulties, additional funding may well be required to determine the source of the abnormal results.

3. Research recommendations that require additional methodological developments and/or would cost more than $500,000:

   - Controlled exposure experiment (CEE) for beaked whales with an appropriate LF source (i.e., one like the SURTASS LFA sonar array or individual array element as is possible). Many complexities are associated with this recommendation, particularly considering the results of the ongoing mid-frequency sonar behavioral response studies demonstrating the importance of real-world exposures for characterizing behavioral responses. It is possible that existing LF sources already in use on Navy ranges could be surrogates for SURTASS LFA sonar, but such extrapolations would need to be considered carefully. SURTASS LFA sonar is currently authorized for use in the western and central North Pacific and eastern Indian oceans, regions in which CEEs have not been conducted, making experiments using the LFA sonar system particularly difficult and costlier, since an experimental infrastructure does not exist. Given the cost and complexities associated with this recommendation, it was ranked as a lower priority. This recommendation should also be revisited as future tagging technologies are developed, particularly for harbor porpoises.

   - Acquire LF behavioral audiograms for harbor porpoise or LF auditory evoked potential (AEP)/auditory brainstem response (ABR) audiograms of beaked whale species. Since meeting of the EOG convened, the Navy funded a study led by James Finneran that correlated AEP measurements of hearing sensitivity with perceived loudness (Muslow et al., 2015). Part of this study included attempts to extend the LF range of AEP measurements, which may be transferable to studies of hearing sensitivity of harbor porpoise or beaked whales. There are difficulties with the transmission of LF sounds, in achieving the required power with manageable laboratory systems, and creating a far-field sound field consistent across the measurement experiment. Muslow et al. (2015) found that AEPs were only successful to frequencies of 10 kHz

for bottlenose dolphins (where 10 kHz is the upper range of what is considered mid-frequency) and 1 kHz for California sea lions (the upper range of what is considered low-frequency). In addition, the correlation of equal latency contours only applied over a limited frequency range, providing limited benefit beyond the frequency range of auditory thresholds. In context of these results, it is currently not feasible to conduct ABR/AEPs for harbor porpoises at frequencies within the range at which SURTASS LFA sonar (100 to 500 Hz) transmits.

The ranking of research and monitoring recommendations has helped inform Navy and NMFS decision makers of the scientific priority, feasibility, and cost of possible experiments to increase understanding of potential effects of SURTASS LFA sonar on harbor porpoises and beaked whales. Discussions amongst Navy decision makers from the Intelligence, Surveillance and Reconnaissance Capabilities Division (OPNAV N974); Office of the Deputy Assistant Secretary of the Navy for the Environment; Office of Naval Research; and Navy Living Marine Resources Program will continue to leverage research among various funded research programs. Although funding for this research has been requested in annual budgets, significant budgetary constraints throughout the Navy and NMFS have prevented those funds being allocated. Ongoing Navy and NMFS discussions are planned with the goal of determining the most efficient and cost-effective way forward for Navy environmental compliance research efforts on possible effects of LFA sonar exposure to these taxa.

2.3.1 Navy-funded Harbor Porpoise Research

The Navy has funded a small geospatial research project to determine the extent of the potential overlap of harbor porpoise's distributional range and habitat with the sound field generated by SURTASS LFA sonar activities, including in the coastal standoff range (i.e., geographic restriction that the LFA sound field not exceeding 180 dB re: 1 µPa [rms] at a distance less than 12 nmi [22 km] from any emergent land), given that the harbor porpoise has a known coastal distribution. Since harbor porpoises are small animals with high metabolic rates, they must remain close to food resources and consume prey frequently, at least every three days (Johnston et al., 2005). Water depth appears to be the single most important predictor of harbor porpoise distribution, with animals typically found in intermediate continental shelf waters (e.g., at depths from 164 to 492 ft [50 to 150 m]) (Isojunno et al., 2012). Harbor porpoises can be found at considerable distances from land but in shallow water areas, such as the German Bight (Gilles et al., 2011), the North Sea (Hammond et al., 2013), and the U.S. west coast (Barlow, 1988). The geospatial analysis of the potential for overlap between harbor porpoise's and SURTASS LFA sonar transmissions has been conducted in a geographical information system environment and is nearing completion.

The Navy's Living Marine Resources (LMR) Program has funded related harbor porpoise research over the last several years. Led by Dr. Ronald Kastelein, an LMR research study is set to determine the effects on harbor porpoise hearing and the behavioral responses to exposure of mid-frequency (3 kiloHertz [kHz]) military sonar. Specifically, the goals of this research are to determine 1) the behavioral response thresholds under varying noise conditions, and 2) the temporary threshold shift (TTS) growth curves, from which the onset of cumulative sound exposure levels for TTS and permanent threshold shift can be determined. These findings would allow federal regulators to set realistic safe underwater sound criteria to prevent hearing injury in harbor porpoises.

2.4 STATUS OF MARINE MAMMAL MONITORING (M3) PROGRAM AND DATA

SURTASS LFA sonar's M3 program uses acoustic data collected from 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, and to use the collected data to further the overall understanding of anthropogenic noise effects on the marine environment. The M3 program has evolved into a valuable tool by which the acoustic activity levels of whales are quantitatively documented and ambient noise level trends are measured over ecologically meaningful ocean scales and time periods under varying ocean noise conditions.

M3 program analysts have identified baleen whale calls and assembled a catalog of vocalizations from blue, fin, humpback, minke, Bryde's, gray, sei, and sperm whales. Additionally, the M3 program has quantified the annual and inter-annual variation in baleen whale singing behavior. Based on over 17 years of data, M3 program analysts can describe the typical seasonal patterns of acoustic activities for blue, fin, humpback, and minke whales. Acoustic data from over seven years now provide insights into the seasonal acoustic and behavior patterns of three additional species of baleen whales (Bryde's, gray, and sei whales) and one odontocete species (sperm whale). Also, the M3 program's analyst's provide considerable expertise to the Navy in classifying oceanic sounds. M3 analysts have resolved the compiled acoustic historical data to identify weather phenomena (i.e., lightning and rain squalls), weapons detonation, earthquakes, hydrothermal venting, known and previously undescribed biologics, and semi-submersible oil and gas drilling rigs.

From January 2017 through August 2018, M3 acoustic analysts identified 14,112 acoustic occurrences of seven cetacean species from Navy sensors. Acoustic data were collected, archived, and analyzed to identify three types of acoustic signatures for five cetacean species, including 1) songs from the blue, fin, humpback, and minke whales; 2) calls from blue, Bryde's, fin, humpback, minke, and sei whales; and 3) foraging clicks from sperm whales. Additionally, thousands of tracks of these species from a wide variety of geographic and behavioral contexts were identified and archived (DoN, 2018a). These M3 Program accomplishments and others are described in more detail in the 2017 to 2018 M3 Program annual report (Appendix C).

At present, the M3 program's data are classified, as are the data reports and products 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 on the association between fin whale singing and swim speed has been prepared and submitted to a peer-reviewed scientific journal for publication and is currently being revised per the peer-review process. A similar paper on humpback whale singing and swim speed associations is being prepared for internal Navy declassification and review.

2.5 STATUS OF AMBIENT NOISE DATA

The Navy collects ambient noise data on the marine environment when the SURTASS passive towed horizontal line array is deployed. However, because the collected ambient noise data may also contain

sensitive acoustic military information, the Navy classifies the data, making them unavailable to the public. The ambient noise data, especially from areas of the ocean for which marine ambient noise data may be lacking, would be a beneficial addition to the comprehensive ocean noise budget (i.e., an accounting of the relative contributions of various underwater sources to the ocean noise field) for the world's oceans.

In acknowledgement of the valuable data the Navy routinely collects, NMFS has recommended that the Navy continue to explore the feasibility of declassifying and archiving the ambient noise data with the goal of ultimately making it available to scientists with the appropriate credentials. The Navy continues to study the feasibility of declassifying portions of its ambient noise data after all related security concerns have been resolved. As an initial step in this process, SURTASS LFA sonar's M3 program is working to compile information on the ambient noise data that have been collected from various systems and assess the range of and usable content of the data prior to further discussions on data dissemination, either at a classified or unclassified level.

2.6 Marine Mammal Ship Strike Reporting

Per condition of the NDE and ESA permit for SURTASS LFA sonar, the Navy is responsible for systematically observing SURTASS LFA sonar activities for the presence of injured or disabled marine mammals. During the 2017 to 2018 annual period, no struck, injured, or disabled marine mammals (or sea turtles) were observed prior, during, or after the execution of SURTASS LFA sonar activities or during normal shipboard operations or transit.

2.7 Marine Mammal Stranding Reporting

Additionally, the NDE and ESA permit for SURTASS LFA sonar calls for the Navy to monitor the principal marine mammal stranding networks and media to temporally and spatially correlate any marine mammal strandings with SURTASS LFA sonar activities. The Navy compiled marine mammal stranding information from all regions where SURTASS LFA sonar activities were conducted during the annual NDE period, including from e-news alerts, social media for domestic and international stranding organizations, and by searching available stranding networks for relevant regional information. The majority of the stranding data for the western North Pacific and eastern Indian oceans was reported by the International Dolphin and Whale Stranding Network (https://www.facebook.com/Stranding Network/), which is an informal group of scientists, advocates, and concerned individuals that maintains a thorough compilation of all strandings of marine mammals reported throughout the world. Data for the Philippines were compiled from the Philippines Marine Mammal Stranding Network, although their database is not currently updated through 2017 and 2018 (http://pmmsn.org/). Marine mammal stranding data for Hawaii, Guam, and CNMI were compiled by West (2018) and reviewed by the Navy.

The Navy has evaluated the spatial and temporal overlap of the compiled strandings with SURTASS LFA sonar activities, and no overlap exists. No mass strandings of marine mammals occurred in the study area for SURTASS LFA sonar during the last year, and no individual strandings of marine mammals occurred in the vicinity of SURTASS LFA sonar activities during or directly following the periods when LFA sonar transmissions were conducted. Although causes for the marine mammal strandings were rarely given, when reported, the cause of many marine mammal strandings and mortalities was typically due to ingestion of plastics or entanglement in fishing gear.

3 AFFECTED MARINE MAMMAL STOCKS

In its 2017 to 2018 LOAs application, the Navy provided estimates of the percentage of marine mammal stocks potentially affected during a proposed 20 nominal missions in the 15 mission/modeling areas where SURTASS LFA sonar might be deployed from August 2017 through August 2018 (DoN, 2017). The same analysis methodology and population data (densities and abundances) were utilized to compute the post-mission take estimates of marine mammals using the actual number of LFA sonar hours transmitted during each mission. These take estimates were included in the quarterly mission reports submitted to NMFS, with the Navy maintaining a running total of the marine mammal stock percentages to ensure that no more than 12 percent of any marine mammal stock were taken incidentally to the execution of SURTASS LFA sonar activities.

In this annual report, the Navy provides the compiled quarterly and annual post-mission summaries of the estimated percentages of the marine mammal stocks and number of marine mammals in each stock incidentally harassed by the LFA sonar transmissions both for each SURTASS LFA sonar vessel (Appendix B) and all combined vessels (Table 3). An overview of the methodology, criteria, and thresholds used for the predictive modeling of the acoustic impact analysis and resulting computation of the incidental harassment estimates detailed herein may be found in the SURTASS LFA sonar Draft SEIS/SOEIS (DoN, 2018).

3.1 POST-MISSION ESTIMATES OF POTENTIALLY AFFECTED MARINE MAMMAL STOCKS

Overall mission planning during the annual period was fundamentally based on national security and anti-submarine warfare requirements as well as the need for MMPA Level B incidental harassment of any one stock of marine mammals to remain under 12 percent annually. Thus, mission planning for each quarter of the annual NDE period considered the estimated running total of the marine mammal stock percentage 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. Due to the effectiveness of mitigation monitoring for SURTASS LFA sonar, no MMPA Level A harassment was approved nor estimated.

During the August 2017 through August 2018 NDE period, the highest percentage of any marine mammal stock taken by MMPA Level B incidental harassment from exposure to the 23 total hr of LFA sonar transmissions was 5.4 percent of the WNP stock and DPS of humpback whales (Table 3), which is well below the approved limit of 12 percent. The endangered WNP humpback whale stock/DPS is a small stock/DPS that is represented by a population estimated as 1,328 individuals and occurs in many of the western North Pacific mission/modeling areas for SURTASS LFA sonar. The second highest Level B take percentage for the annual period was 1.0 percent of the WNP of long-beaked common dolphins. The highest number of individuals in any stock affected by Level B harassment was 2,899 individuals of the WNP stock of long-beaked common dolphins, which is represented by a population estimated at 272,189 individuals (Table 3).

4 ASSESSMENT OF LONG-TERM AND CUMULATIVE EFFECTS

The Navy's conclusion that SURTASS LFA sonar activities had a negligible impact on affected marine mammal stocks or species of marine mammals and are not expected to have any reasonably foreseeable population-level consequences on the stocks in the western North Pacific was consistent with previous assessments of SURTASS LFA sonar impacts on regional stocks of marine mammals. Likewise, the Navy's

Table 3. Summary of the Stock Percentages and Numbers of Marine Mammal Individuals in Those Stocks[1] Affected by all SURTASS LFA Sonar Transmissions During the August 2017 to August 2018 NDE Period. ESA-listed Marine Mammals Highlighted.

			Level B Harassment										Level A Harassment (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	
All Affected Marine Mammal Species/Species Groups	Number Marine Mammals in Stock	Stock Name[1]	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	WNP			0.00465%	1			0.0027%	1	0.00735%	2	0.00000%	0
Bryde's whale	20,501	WNP			0.01859%	4	0.01085%	3	0.07023%	15	0.09966%	22	0.00000%	0
Common minke whale	25,049	WNP O			0.11647%	30	0.05663%	15	0.42346%	107	0.59657%	152	0.00000%	0
	2,611	WNP J					0.29636%	8			0.29636%	8	0.00000%	0
Fin whale	9,250	WNP			0.09769%	10	0.00732%	1	0.06250%	6	0.16751%	17	0.00000%	0
Humpback whale	1,328	WNP stock/DPS			3.66007%	49	0.05194%	1	1.67102%	23	5.38303%	73	0.00000%	0
North Pacific right whale	922	WNP			0.00527%	1	0.01381%	1	0.02233%	1	0.04140%	3	0.00000%	0
Omura's whale	1,800	WNP			0.02117%	1	0.01235%	1	0.07999%	2	0.11351%	4	0.00000%	0
Western North Pacific gray whale	140	WNP					0.01638%	1			0.01638%	1	0.00000%	0
Odontocetes														
Blainville's beaked whale	8,032	WNP			0.03764%	4	0.03341%	3	0.10039%	9	0.17144%	16	0.00000%	0
Common bottlenose dolphin	168,791	WNP			0.03895%	66			0.13148%	222	0.17043%	288	0.00000%	0
	105,138	IA					0.00298%	4			0.00298%	4	0.00000%	0
Cuvier's beaked whale	90,725	WNP			0.03599%	33	0.00177%	2	0.09598%	88	0.13375%	123	0.00000%	0
False killer whale	16,668	WNP			0.08257%	14			0.27310%	46	0.35567%	60	0.00000%	0
	9,777	IA					0.05296%	6			0.05296%	6	0.00000%	0
Fraser's dolphin	220,789	WNP			0.01571%	35	0.01616%	36	0.04808%	107	0.07995%	178	0.00000%	0
Ginkgo-toothed beaked whale	22,799	NP			0.01326%	4	0.01177%	3	0.03537%	9	0.06040%	16	0.00000%	0
Killer whale	12,256	WNP			0.00390%	1	0.00440%	1	0.01223%	2	0.02053%	4	0.00000%	0
Kogia spp.	350,553	WNP			0.00560%	20	0.00308%	11	0.01522%	54	0.02390%	85	0.00000%	0
Long-beaked common dolphin	279,182	WNP			0.21496%	601	0.21227%	593	0.61046%	1,705	1.03770%	2,899	0.00000%	0
Longman's beaked whale	4,571	WNP			0.03307%	2	0.02936%	2	0.08820%	5	0.15062%	9	0.00000%	0
Melon-headed whale	36,770	WNP			0.05524%	21	0.05430%	20	0.18271%	68	0.29225%	109	0.00000%	0
Pacific white-sided dolphin	931,000	NP			0.00576%	54			0.01898%	177	0.02474%	231	0.00000%	0
Pantropical spotted dolphin	438,064	WNP			0.01184%	52	0.01599%	36	0.04299%	189	0.07082%	277	0.00000%	0
Pygmy killer whale	30,214	WNP			0.03298%	10	0.00216%	1	0.10910%	33	0.14425%	44	0.00000%	0
Risso's dolphin	83,289	WNP			0.07952%	67			0.21731%	181	0.29683%	248	0.00000%	0
	83,289	IA					0.07584%	64			0.07584%	64	0.00000%	0
Rough-toothed dolphin	145,729	WNP			0.02550%	38	0.01077%	16	0.07150%	105	0.10777%	159	0.00000%	0
Short-beaked common dolphin	3,286,163	WNP			0.00886%	292			0.02517%	828	0.03403%	1,120	0.00000%	0
Short-finned pilot whale	53,608	WNP			0.16614%	90	0.01270%	7	0.47019%	253	0.64904%	350	0.00000%	0
Sperm whale	102,112	NP			0.00629%	7	0.00557%	6	0.01686%	18	0.02872%	31	0.00000%	0
Spinner dolphin	1,015,059	WNP			0.00031%	4	0.00021%	3	0.00112%	12	0.00164%	19	0.00000%	0
Striped dolphin	570,038	WNP			0.02185%	125			0.07934%	453	0.10119%	578	0.00000%	0
	570,038	IA					0.00261%	15			0.00261%	0	0.00000%	0

1 WNP=Western North Pacific; IA= Inshore Archipelago; NP=North Pacific; DPS=distinct population segment

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 SURTASS LFA sonar activities do not pose a reasonably foreseeable significant adverse impact to marine mammals.

The greatest cumulative impact associated with SURTASS LFA sonar activities 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 use 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 the annual period. The Navy was approved to use a total of 1,020 hr of LFA sonar transmit time across all four SURTASS LFA sonar vessels during the annual period but transmitted far fewer hours for all vessels during the 2017 to 2018 annual period. 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 central or western North Pacific Ocean or eastern Indian Ocean, commercial maritime traffic is heavy.

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 1,020 hr per year and at a 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, as previously concluded, the potential for accumulation of noise due to the intermittent transmission of SURTASS LFA sonar is considered negligible (DoN, 2017). 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.

5 LITERATURE CITED

Barlow, J. (1988). Harbor porpoise, *Phocoena phocoena*, abundance estimation for California, Oregon, and Washington: I. Ship surveys. *Fishery Bulletin, 86*(3), 417-432.

Baumann-Pickering, S., Roch, M. A., Jr, R. L. B., Simonis, A. E., McDonald, M. A., Solsona-Berga, A., Oleson, E. M., Wiggins, S. M., & Hildebrand, J. A. (2014). Spatio-temporal patterns of beaked whale echolocation signals in the North Pacific. *PLoS ONE, 9*(1), e86072. doi:10.1371/journal.pone.0086072.

Cranford, T. W., & Krysl, P. (2015). Fin whale sound reception mechanisms: Skull vibration enables low-frequency hearing. *PLoS ONE, 10*(1), e0116222. doi:10.1371/journal.pone.0116222.

Department of the Navy (DoN). (2001). *Final overseas environmental impact statement and environmental impact statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar.* Washington, DC: Chief of Naval Operations, Department of the Navy.

DoN. (2017). *Application for annual letters of authorization for the employment of Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar onboard four vessels under Section 101 (A)(5)(A) of the Marine Mammal Protection Act; April 2017.* Washington, D.C.: Department of the Navy, Chief of Naval Operations. 238 pages.

DoN. (2018). *Draft* supplemental *environmental impact statement and supplemental overseas environmental impact statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar.* Washington, DC: Chief of Naval Operations, Department of the Navy.

DoN. (2018a). *Annual report of the marine mammal monitoring (M3) program.* Prepared by Marine Acoustics, Inc. Washington, DC: Chief of Naval Operations, Department of the Navy. 12 pages.

Ellison, W. T., & P. J. Stein. (2001). *SURTASS LFA high frequency marine mammal monitoring (HF/M3) system: System description and test and evaluation*. Marine Acoustics, Inc. and Scientific Solutions, Inc., 26 November 1999. Retrieved from <http://www.surtass-lfa-eis.com/docs/HF-M3%20Ellison%20Report%202-4a.pdf>.

Gilles, A., Adler, S., Kaschner, K., Scheidat, M., & Siebert, U. (2011). Modelling harbour porpoise seasonal density as a function of the German Bight environment: implications for management. *Endangered Species Research, 14*(2), 157-169. doi: 10.3354/esr00344.

Hammond, P. S., Macleod, K., Berggren, P., Borchers, D. L., Burt, L., Cañadas, A., . . . Vázquez, J. A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation, 164*(2013), 107-122. doi: http://dx.doi.org/10.1016/j.biocon.2013.04.010.

Hildebrand, J. A. (2005). Impacts of anthropogenic sound. Pages 101-124 in J.E. Reynolds, W.F. Perrin, R.R. Reeves, S. Montgomery, and T.J. Ragen, (Eds). *Marine mammal research: Conservation beyond crisis.* Baltimore, Maryland: Johns Hopkins University Press.

Hildebrand, J. A. (2009). Anthropogenic and natural sources of ambient noise in the ocean. *Marine Ecology Progress Series, 395*, 5-20.

Isojunno, S., Matthiopoulos, J., & Evans, P. G. H. (2012). Harbour porpoise habitat preferences: robust spatio-temporal inferences from opportunistic data. *Marine Ecology Progress Series, 448*, 155-170. doi: 10.3354/meps09415.

Johnston, D. W., Westgate, A. J., & Read, A. J. (2005). Effects of fine-scale oceanographic features on the distribution and movements of harbour porpoises Phocoena phocoena in the Bay of Fundy. *Marine Ecology Progress Series, 295*, 279-293.

Muslow, J., Schlundt, C. E., Brandt, L., & Finneran, J. J. (2015). Equal latency contours for bottlenose dolphins (*Tursiops truncatus*) and California sea lions (*Zalophus californianus*). *The Journal of the Acoustical Society of America, 138*(5), 2678-2691.

NMFS. (2018). *2018 Revision to: Technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (Version 2.0): Underwater threshold for onset of permanent and temporary threshold shifts.* Silver Spring, MD. NOAA Technical Memorandum NMFS-OPR-59.

Tournadre, J. (2014). Anthropogenic pressure on the open ocean: The growth of ship traffic revealed by altimeter data analysis. *Geophysical Research Letters, 41*(22), 7924-7932. doi:10.1002/2014gl061786.

West, K. (2018). Unpublished marine mammal stranding data and personal communication between Dr. Kristi West, Hawaii Pacific University, and Ms. Cheryl Schroeder, Marine Acoustics, Inc. on 5-7 May 2018.

APPENDIX A: 2017 NATIONAL DEFENSE EXEMPTION FROM REQUIREMENTS OF THE MARINE MAMMAL PROTECTION ACT FOR DEPARTMENT OF DEFENSE SURVEILLANCE TOWED ARRAY SENSOR SYSTEM LOW FREQUENCY ACTIVE SONAR MILITARY READINESS ACTIVITIES

DEPUTY SECRETARY OF DEFENSE
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WASHINGTON, DC 20301-1010

AUG 1 0 2017

MEMORANDUM FOR SECRETARY OF THE NAVY

SUBJECT: National Defense Exemption from Requirements of the Marine Mammal Protection Act for Department of Defense Surveillance Towed Array Sensor System Low Frequency Active Sonar Military Readiness Activities

Pursuant to Title 16, Section 1371(f), of the United States Code, and having conferred with the Secretary of Commerce, I have determined that it is necessary for the national defense to exempt all military readiness activities that employ Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) sonar from compliance with the requirements of the Marine Mammal Protection Act, Title 16, Sections 1361-1421h, of the United States Code. A military readiness activity is defined in Section 315(f) of Public Law 107-314.

This exemption is effective August 13, 2017, and shall remain in force for a period of two years from that date or until such time as the National Marine Fisheries Service issues Regulations and Letters of Authorization under Title 16, Section 1371 for SURTASS LFA sonar military readiness activities, whichever is earlier. During the exemption period, all military readiness activities that involve the use of SURTASS LFA sonar shall comply with the parameters and mitigation, monitoring, and reporting measures set forth in Attachment 1.

Attachment:
As stated

Attachment 1

Surveillance Towed Array Sensor System (SURTASS) Low Frequency Active (LFA) Sonar Mitigation, Monitoring and Reporting Measures

I. PARAMETERS

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

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

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

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

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

II. MITIGATION

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

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

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

   (c) **Commercial and Recreational SCUBA Diving Mitigation Zone**

Attachment 1

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(h) **Geographic Restrictions:**

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

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

(B) At a distance of less than 1 km (0.62 mi; 0.54 nmi) seaward of the outer perimeter of any Offshore Biologically Important Area (OBIA) for marine mammals designated in the table below ,or

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identified through the Adaptive Management Process, specified herein, within the period of the NDE's effectiveness.

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

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

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Olympic Coast NMS and Prairie, Barkley Canyon, and Nitnat Canyon	Northeastern Pacific Ocean	Olympic NMS: December, January, March, and May annually. Prairie, Barkley Canyon, and Nitnat Canyon: June through September annually
Abrolhos Bank	Southwest Atlantic Ocean	August through November, annually
Grand Manan North Atlantic Right Whale Critical Habitat	Bay of Fundy, Canada	June through December, annually
Eastern Gulf of Mexico	Eastern Gulf of Mexico	Year-round
Southern Chile Coastal Waters	Gulf of Corcovado, Southeast Pacific Ocean; Southwestern Chile	February to April, annually
Offshore Sri Lanka	North-Central Indian Ocean	December through April, annually
Camden Sound/Kimberly Region	Southeast Indian Ocean; northwestern Australia	June through September, annually
Perth Canyon	Southeast Indian Ocean; southwestern Australia	January through May, annually
Southwest Australia Canyons	Southeast Indian Ocean; southwestern Australia	Year-round

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

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

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

III. MONITORING

1. The Navy must perform:

(a) **Visual Mitigation Monitoring:**

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

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

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

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the SURTASS vessels shall have lookouts to maintain a topside watch with standard binoculars (7x) and with the naked eye.

(b) **Passive Acoustic Mitigation Monitoring:**
(1) Use the low frequency, passive SURTASS sonar system to listen for vocalizing marine mammals.

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

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

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

3. The Navy must:

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

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

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

IV. REPORTING

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

(a) Dates, times, and location of each vessel during each mission.
(b) Information on sonar transmissions during each mission and records of any delays or suspensions.
(c) Location of the SURTASS LFA sonar mitigation and buffer zones in relation to the LFA sonar array.

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

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

(a) An unclassified summary of the year's quarterly reports.
(b) The Navy's estimates of the percentages of marine mammal stocks affected by SURTASS LFA sonar military readiness activities (both within and outside the LFA sonar mitigation and buffer zones), using predictive modeling based on mission locations, dates/times of operations, system characteristics, LFA sonar transmission durations, oceanographic environmental conditions, and animal demographics.
(c) An analysis of the effectiveness of the mitigation measures with recommendations for improvements, where applicable.
(d) An assessment of any long-term effects from SURTASS LFA sonar military readiness activities a.
(e) Any discernible or estimated cumulative impacts from SURTASS LFA sonar military readiness activities.

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

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

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

5. **Marine Mammal Stranding Reporting.** During SURTASS LFA sonar military readiness activities personnel onboard a SURTASS LFA vessel shall systematically observe for injured or disabled marine mammals and

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monitor the principal marine mammal stranding networks and other media to correlate analysis of any whale strandings that could potentially be associated with SURTASS LFA sonar activities, the Navy shall:

(a) Ensure that NMFS is notified immediately, or as soon as clearance procedures allow, if an injured, stranded, or dead marine mammal is observed during or shortly after (within 24 hours) and in the vicinity of any SURTASS LFA sonar activities. The Navy will report the incident to the Chief, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Dale.Youngkin@noaa.gov.

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

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

APPENDIX B: 2017 TO 2018 SUMMARIES OF MARINE MAMMAL INCIDENTAL HARASSMENT FROM ALL SURTASS LFA SONAR VESSELS

Table B-1. Summary of the Marine Mammal Harassment Associated with the USNS VICTORIOUS' (T-AGOS 19) SURTASS LFA Sonar Activites During the August 2017 to August 2018 Period Under the NDE.

Marine Mammal Species/Species Groups	Number Animals in Stock	Stock Name[1]	Level B Harassment										Level A Harassment (with Mitigation)	
			Quarter 1 (August to November)		Quarter 2 (November to February)		Quarter 3 (February to May)		Quarter 4 (May to August)		Total Annual		Total for Quarter and Annual Period	
			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	WNP			0.00465%	1					0.00465%	1	0.00000%	0
Bryde's whale	20,501	WNP			0.01859%	4					0.01859%	4	0.00000%	0
Common minke whale	25,049	WNP O			0.11647%	30					0.11647%	30	0.00000%	0
Fin whale	9,250	WNP			0.09769%	10					0.09769%	10	0.00000%	0
Humpback whale	1,328	WNP stock/ DPS			3.66007%	49					3.66007%	49	0.00000%	0
North Pacific right whale	922	WNP			0.00527%	1					0.00527%	1	0.00000%	0
Omura's whale	1,800	WNP			0.02117%	1					0.02117%	1	0.00000%	0
Odontocetes														
Blainville's beaked	8,032	WNP			0.03764%	4					0.03764%	4	0.0000%	0
Common bottlenose dolphin	168,791	WNP			0.03895%	66					0.03895%	66	0.0000%	0
Cuvier's beaked whale	90,725	WNP			0.03599%	33					0.03599%	33	0.0000%	0
False killer whale	16,668	WNP			0.08257%	14					0.08257%	14	0.0000%	0
Fraser's dolphin	220,789	WNP			0.01571%	35					0.01571%	35	0.0000%	0
Gingko-toothed beaked whale	22,799	NP			0.01326%	4					0.01326%	4	0.0000%	0
Killer whale	12,256	WNP			0.00390%	1					0.00390%	1	0.0000%	0
Kogia spp.	350,553	WNP			0.00560%	20					0.00560%	20	0.0000%	0
Long-beaked common dolphin	279,182	WNP			0.21496%	601					0.21496%	601	0.0000%	0
Longman's beaked whale	4,571	WNP			0.03307%	2					0.03307%	2	0.0000%	0
Melon-headed whale	36,770	WNP			0.05524%	21					0.05524%	21	0.0000%	0
Pacific white-sided dolphin	931,000	NP			0.00576%	54					0.00576%	54	0.0000%	0
Pantropical spotted dolphin	438,064	WNP			0.01184%	52					0.01184%	52	0.0000%	0
Pygmy killer whale	30,214	WNP			0.03298%	10					0.03298%	10	0.0000%	0
Risso's dolphin	83,289	WNP			0.07952%	67					0.07952%	67	0.0000%	0
Rough-toothed dolphin	145,729	WNP			0.02550%	38					0.02550%	38	0.0000%	0
Short-beaked common dolphin	3,286,163	WNP			0.00886%	292					0.00886%	292	0.0000%	0
Short-finned pilot whale	53,608	WNP			0.16614%	90					0.16614%	90	0.0000%	0
Sperm whale	102,112	NP			0.00629%	7					0.00629%	7	0.0000%	0
Spinner dolphin	1,015,059	WNP			0.00031%	4					0.00031%	4	0.0000%	0
Striped dolphin	570,038	WNP			0.02185%	125					0.02185%	125	0.0000%	0
			No LFA Sonar Missions—Negative Activity Report				No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report					

Table B-2. Summary of the Marine Mammal Harassment Associated with the USNS ABLE's (T-AGOS 20) SURTASS LFA Sonar Activites During the August 2017 to August 2018 Period Under the NDE.

Marine Mammal Species/Species Groups	Number Animals in Stock	Stock Name[1]	Level B Harassment										Level A Harassment (with Mitigation)	
			Quarter 1 (August to November)		Quarter 2 (November to February)		Quarter 3 (February to May)		Quarter 4 (May to August)		Total Annual		Total for Quarter and Annual Period	
			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														
Bryde's whale	20,501	WNP					0.01085%	3			0.01085%	3	0.00000%	0
Common minke whale	25,049	WNP O					0.05663%	15			0.05663%	15	0.00000%	0
	2,611	WNP J					0.29636%	8			0.29636%	8	0.00000%	0
Fin whale	9,250	WNP					0.00732%	1			0.00732%	1	0.00000%	0
Humpback whale	1,328	WNP DPS					0.05194%	1			0.05194%	1	0.00000%	0
North Pacific right whale	922	WNP					0.01381%	1			0.01381%	1	0.00000%	0
Omura's whale	1,800	NP					0.01235%	1			0.01235%	1	0.00000%	0
Western North Pacific gray whale	140	WNP					0.01638%	1			0.01638%	1	0.00000%	0
Odontocetes														
Blainville's beaked	8,032	WNP					0.03341%	3			0.03341%	3	0.00000%	0
Common bottlenose dolphin	105,138	IA					0.00298%	4			0.00298%	4	0.00000%	0
Cuvier's beaked whale	90,725	WNP					0.00177%	2			0.00177%	2	0.00000%	0
Deraniyagala's beaked whale	22,799	NP					0.01177%	3			0.01177%	3	0.00000%	0
False killer whale	9,777	IA					0.05296%	6			0.05296%	6	0.00000%	0
Fraser's dolphin	220,789	WNP					0.01616%	36			0.01616%	36	0.00000%	0
Gingko-toothed beaked whale	22,799	NP					0.01177%	3			0.01177%	3	0.00000%	0
Killer whale	12,256	WNP					0.00440%	1			0.00440%	1	0.00000%	0
Kogia spp.	350,553	WNP					0.00308%	11			0.00308%	11	0.00000%	0
Long-beaked common dolphin	279,182	WNP					0.21227%	593			0.21227%	593	0.00000%	0
Longman's beaked whale	4,571	WNP					0.02936%	2			0.02936%	2	0.00000%	0
Melon-headed whale	36,770	WNP					0.05430%	20			0.05430%	20	0.00000%	0
Pantropical spotted dolphin	438,064	WNP					0.01599%	36			0.01599%	36	0.00000%	0
Pygmy killer whale	30,214	WNP					0.00216%	1			0.00216%	1	0.00000%	0
Risso's dolphin	83,289	IA					0.07584%	64			0.07584%	64	0.00000%	0
Rough-toothed dolphin	145,729	WNP					0.01077%	16			0.01077%	16	0.00000%	0
Short-finned pilot whale	53,608	WNP					0.01270%	7			0.01270%	7	0.00000%	0
Sperm whale	102,112	NP					0.00557%	6			0.00557%	6	0.00000%	0
Spinner dolphin	1,015,059	WNP					0.00021%	3			0.00021%	3	0.00000%	0
Striped dolphin	570,038	IA					0.00261%	15			0.00261%	15	0.00000%	0
			No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report				No LFA Sonar Missions—Negative Activity Report					

Table B-3. Summary of the Marine Mammal Harassment Associated with the USNS EFFECTIVE's (T-AGOS 21) SURTASS LFA Sonar Activites During the August 2017 to August 2018 Period Under the NDE.

Marine Mammal Species/Species Groups	Number Animals in Stock	Stock Name	Level B Harassment										Level A Harassment (with Mitigation)	
			Quarter 1 (August to November)		Quarter 2 (November to February)		Quarter 3 (February to May)		Quarter 4 (May to August)		Total Annual		Total for Quarter and Annual Period	
			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														
Bryde's whale	20,501	WNP												
Common minke whale	25,049	WNP O												
Odontocetes														
Blainville's beaked whale	8,032	WNP												
Common bottlenose dolphin	168,791	WNP												
Cuvier's beaked whale	90,725	WNP												
False killer whale	16,668	WNP												
Fraser's dolphin	220,789	WNP												
Gingko-toothed beaked whale	22,799	NP												
Killer whale	12,256	WNP												
Long-beaked common dolphin	279,182	WNP												
Longman's beaked whale	4,571	WNP												
Melon-headed whale	36,770	WNP												
Pantropical spotted dolphin	438,064	WNP												
Risso's dolphin	83,289	WNP												
Rough-toothed dolphin	145,729	WNP												
Short-beaked common dolphin	3,286,163	WNP												
Short-finned pilot whale	53,608	WNP												
Sperm whale	102,112	NP												
Spinner dolphin	1,015,059	WNP												
Striped dolphin	570,038	WNP												
			No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report					

Table B-4. Summary of the Marine Mammal Harassment Associated with the USNS MPECCABLE's (T-AGOS 23) SURTASS LFA Sonar Activies During the August 2017 to August 2018 Period Under the NDE.

Marine Mammal Species/Species Groups	Number Animals in Stock	Stock Name	Level B Harassment										Level A Harassment (with Mitigation)	
			Quarter 1 (August to November)		Quarter 2 (November to February)		Quarter 3 (February to May)		Quarter 4 (May to August)		Total Annual		Total for Quarter and Annual Period	
			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	WNP							0.00270%	1	0.00270%	1	0.0000%	0
Bryde's whale	20,501	WNP							0.07023%	15	0.07023%	15	0.0000%	0
Common minke whale	25,049	WNP O							0.42346%	107	0.42346%	107	0.0000%	0
Fin whale	9,250	WNP							0.06250%	6	0.06250%	6	0.0000%	0
Humpback whale	1,328	WNP stock and DPS							1.67102%	23	1.67102%	23	0.0000%	0
North Pacific right whale	922	WNP							0.02233%	1	0.02233%	1	0.0000%	0
Omura's whale	1,800	WNP							0.07999%	2	0.07999%	2	0.0000%	0
Odontocetes														
Blainville's beaked whale	8,032	WNP							0.10039%	9	0.10039%	9	0.0000%	0
Common bottlenose dolphin	168,791	WNP							0.13148%	222	0.13148%	222	0.0000%	0
Cuvier's beaked whale	90,725	WNP							0.09598%	88	0.09598%	88	0.0000%	0
False killer whale	16,668	WNP							0.27310%	46	0.27310%	46	0.0000%	0
Fraser's dolphin	220,789	WNP							0.04808%	107	0.04808%	107	0.0000%	0
Ginkgo-toothed beaked whale	22,799	NP							0.03537%	9	0.03537%	9	0.0000%	0
Killer whale	12,256	WNP							0.01223%	2	0.01223%	2	0.0000%	0
Kogia spp.	350,553	WNP							0.01522%	54	0.01522%	54	0.0000%	0
Long-beaked common dolphin	279,182	WNP							0.61046%	1705	0.61046%	1705	0.0000%	0
Longman's beaked whale	4,571	WNP							0.08820%	5	0.08820%	5	0.0000%	0
Melon-headed whale	36,770	WNP							0.18271%	68	0.18271%	68	0.0000%	0
Pacific white-sided dolphin	931,000	NP							0.01898%	177	0.01898%	177	0.0000%	0
Pantropical spotted dolphin	438,064	WNP							0.04299%	189	0.04299%	189	0.0000%	0
Pygmy killer whale	30,214	WNP							0.10910%	33	0.10910%	33	0.0000%	0
Risso's dolphin	83,289	WNP							0.21731%	181	0.21731%	181	0.0000%	0
Rough-toothed dolphin	145,729	WNP							0.07150%	105	0.07150%	105	0.0000%	0
Short-beaked common dolphin	3,286,163	WNP							0.02517%	828	0.02517%	828	0.0000%	0
Short-finned pilot whale	53,608	WNP							0.47019%	253	0.47019%	253	0.0000%	0
Sperm whale	102,112	NP							0.01686%	18	0.01686%	18	0.0000%	0
Spinner dolphin	1,015,059	WNP							0.00112%	12	0.00112%	12	0.0000%	0
Striped dolphin	570,038	WNP							0.07934%	453	0.07934%	453	0.0000%	0
			No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report		No LFA Sonar Missions—Negative Activity Report							

APPENDIX C: MARINE MAMMAL MONITORING (M3) ANNUAL REPORT, 2017 TO 2018

ANNUAL REPORT OF THE MARINE MAMMAL MONITORING (M3) PROGRAM

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1 PURPOSE

The purpose of the Marine Mammal Monitoring (M3) program, a monitoring component of the Surveillance Towed Array Senor System Low Frequency Active (SURTASS LFA) sonar program, is to utilize the Navy's fixed and mobile passive acoustic monitoring systems to enhance the Navy's collection of long-term data on individual and populations of acoustically-active marine mammals, principally baleen whales. The M3 program collects acoustic data on the behavioral range of vocalizing (calling and singing) whales and on the influences of anthropogenic activities on 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. The purpose of this Annual Report is to provide a description of the current M3 program, its benefits, products, actions, and accomplishments, as well as future M3 program goals. Overall, in 2017 and three quarters of 2018 (1 January 2017 through 30 September 2018), the M3 program generated more than 4,510 marine mammal tracks[1] containing over 29,007 positions of acoustically-active marine mammals.

2 M3 PROGRAM

2.1 Background

The M3 program was initiated in the fall of 1992 as an independent scientific research effort to make use of the acoustic data on oceanic and biological sounds available through the U.S. Navy's Integrated Undersea Surveillance System (IUSS). The primary goal of the M3 program is to use IUSS data to fill data gaps and to further the overall understanding of anthropogenic noise effects on the marine environment. The M3 program was identified as part of the Long Term Monitoring program in the Navy's SURTASS LFA Sonar Final Overseas Environmental Impact Statement/Environmental Impact Statements (DoN, 2001). The M3 program has evolved into a valuable tool by which the acoustic activity levels of whales are quantitatively documented and ambient noise level trends are measured over ecologically meaningful ocean scales and time periods under varying ocean noise conditions.

M3 data are collected to: 1) document occurrence, distribution, and behaviors of acoustically active whale species over ocean basin and decadal scales; 2) objectively assess changes in marine mammal activity levels under normal conditions (e.g., weather, wind, time of year, or time of day) relative to acoustic conditions with varying levels of anthropogenic sources (e.g., seismic profiler[2], naval sonar, shipping, or fishing activities); 3) uniquely inform environmental assessments of current and future anti-submarine warfare systems; and 4) assemble a long-term database of ocean environmental data to enable scientifically-based evaluations of potential influences on cetaceans or other marine species.

2.2 M3 Program History

In the fall of 1992, the U.S. Navy initiated the Whales '93 program to evaluate the potential of the IUSS for detecting, locating, and tracking whales, as well as determining their seasonal distributions and

[1] For the M3 program, the term "track" refers to a time series of successive acoustic locations for the same acoustically-active whale (i.e., an acoustic track).
[2] The term seismic profiler refers to a vessel operating a seismic airgun array or arrays as part of a geological and geophysical survey, usually to explore for sub-bottom oil and gas but also to conduct basic research.

movements. The Whales '93 team collected data at Naval Ocean Processing Facilities (NOPFs) for the North Atlantic and North Pacific Oceans. The data collection efforts in this three-year Whales '93 program yielded unprecedented amounts of new information on acoustically-active marine mammals in the North Atlantic and North Pacific oceans (Costa, 1993; Watkins et al., 2000, 2004; Clark and Gagnon, 2002). The Whales '93 effort continued through 1996 and included a second experiment, Whales '95. The objective of the Whales '95 experiment was to contribute to the Navy's overall knowledge of marine mammal distributions and movements, which would inform Navy operational and research planning. Data were collected via the disestablished San Nicholas Island Sound Surveillance System (SOSUS) arrays during Whales '95, which were correlated with data from a ship-based bioacoustics, passive towed horizontal line array (Clark and Fristrup, 1997; Fristrup and Clark, 1997). The success of these initial research efforts led to the evolution of the M3 program, which in 2002 became part of the NOAA/NMFS (National Marine Fisheries Service) permit requirements during the first Marine Mammal Protection Act (MMPA) rulemaking for SURTASS LFA sonar (NOAA, 2002).

2.3 Current M3 Program

Since 2002, fixed passive acoustic monitoring systems in the North Atlantic and North Pacific oceans have been used to monitor for the sounds of several baleen whale species and one odontocetes species. Initially, songs from blue, fin, humpback, and minke whales were detected during reproductive seasons. However, as the acoustic expertise of the M3 program team increased and software tools improved, M3 program analysts expanded their research efforts into seasons when these whale species were not singing (Clark and Gagnon, 2002). Subsequently, M3 program analysts identified calls, which are transient signals, from blue, fin, humpback, and minke whales, as well as sounds from Bryde's, gray, sei, and sperm whales. This growing proficiency also allowed M3 program analysts to expand their catalog of marine biological sounds that have not yet be identified to species. This collection of unknown biologic sounds includes some signal types that are clearly from large whales, some that are most likely echolocation clicks from diving odontocetes (e.g., sperm whales), some that are from fishes, and some that are from invertebrates (e.g., diurnal vertical plankton migrations, sea urchins). By authenticating that a sound source is of biological origin, the M3 program has significantly contributed to the proper identification of marine sounds and sound sources that are not of biological origin.

Another example of insights emerging from the large-scale, long-term data set of the M3 program is the quantification of annual and inter-annual variation in large whale singing behavior. Based on over 17 years of data, M3 program analysts can describe the typical seasonal patterns of acoustic activities for four species of baleen whales (blue, fin, humpback, and minke whales). Additionally, data from over seven years now provide insights into the seasonal patterns of an additional three species of baleen whales (Bryde's, gray, and sei whales) and at least one odontocete (sperm whale). A large-scale collection of sounds, acoustic occurrence counts, and tracks at both individual animal and species levels for baleen whale and sperm whale is being assembled. This collection includes increasingly detailed whale movement patterns that likely reflect migrations and possibly feeding.

The Navy is continuing to sponsor the collection of cross-spectral matrix (CSM) data from their passive acoustic arrays. Over 17 years of CSM data are now available. When merged with the M3 program's reports, the combined CSM and M3 information can be used to estimate the total number of singing blue, fin, minke, and humpback whales per unit area. Observations of CSM data over time can also show the interactions and influences of anthropogenic and ambient noise sources on large whale behavior. These collected data and reports provide the Navy with the necessary baseline information to quantify

statistically how baleen whale behavior is affected by various factors, such as ocean basin features, water conditions, seasons, time of day, weather conditions, and ambient noise conditions, as well as specific anthropogenic noise conditions (e.g., seismic profiler, shipping, fishing, naval sonar activities). These baseline data and resultant statistics can be of immense value to the Navy and other Federal agencies to address the issue of potential behavioral effects on marine mammals from Navy sonar and other anthropogenic noise sources (e.g., seismic surveys). IUSS is committed to continuing to sponsor multi-year acoustic monitoring studies of marine mammals using their fixed passive acoustic monitoring systems.

2.4 Regulatory Compliance Requirements

The requirement to collect and assess M3 program data and resulting analyses was instituted in the first MMPA rulemaking for the employment of SURTASS LFA sonar (NOAA, 2002). In the 2017 National Defense Exemption (NDE), data collection by the M3 program was included as a monitoring requirement (DoD, 2017), specifying that the Navy continue to assess data from the M3 program and work toward making some portion of those data, after appropriate security review, available to scientists with clearances; if the analyses produced by the scientists with clearances are deemed to be unclassified, they are to be made publicly available. Furthermore, the Navy is to continue to collect ambient noise data and explore the feasibility of declassifying and archiving the ambient noise data for incorporation into appropriate ocean noise research efforts.

A science paper on fin whale sing-swim speed associations has been declassified and is being resubmitted for peer-review in a scientific journal (Clark et al., in prep RSOS), while a similar paper on humpback whale sing-swim speed associations is being prepared for internal review.

3 M3 PROGRAM BENEFITS AND PRODUCTS

The M3 program provides the Navy, and potentially other government agencies, with long-term sets of acoustic data and analysis reports, as well as various tools for analysis of cetacean vocalizations. These include analysis and visualization tools to document and quantify seasonal occurrences and movements, as well as acoustic behaviors of at least seven large whale species (as well as other marine animals, as feasible) over large ocean areas and multiple annual periods. The analysis report products from the M3 program could be used to rigorously and scientifically compare and evaluate changes in marine mammal metrics as a function of various oceanic environmental conditions, especially pertaining to the acoustic environment, and the sources of changes in that acoustic environment. Importantly, such an evaluation could be conducted for single or cumulative (multiple) acoustic sources, thereby providing an exceptional mechanism for comparatively evaluating the relative contributions from different types and numbers of anthropogenic sound-generating activities.

An invaluable benefit is the considerable expertise the M3 program provides the Navy regarding the classification of ocean sounds. For instance, odd LOFARgram[3] signatures that have been resolved by M3 analysts include various weather phenomena (i.e., lightning and rain squalls), weapons detonation, earthquakes, hydrothermal venting, known and previously undescribed biologics, and semi-submersible

[3] LOFARgram is a term referring to a graphic display, similar to a sound spectrograph/spectrogram, which was generated by the Low Frequency Analysis and Recording (LOFAR) device designed in the late 1950s to analyze LF underwater signals in near-real-time.

drilling rigs. Additionally, the experience and knowledge of the M3 program team have been instrumental in the identification of IUSS equipment casualties, software and hardware issues, and station performance irregularities.

4 M3 PROGRAM ACTIONS AND ACCOMPLISHMENTS IN 2017-2018

The following is a list of the principle M3 program actions and accomplishments from 1 January 2017 through 30 September 2018 (21-month period).

Health Checks: Conducted daily M3 sensor health checks using the Integrated Common Processor (ICP)[4] LOFARgrams and Raven software[5] spectrograms of single-hydrophone data. These displays were used to assist in identifying various IUSS equipment casualties that were not recognized by NOPF operations or maintenance personnel. Assisted with the generation of casualty reports (CASREPTs) for IUSS equipment casualties identified via the M3 program.

Acoustic Display Review: Reviewed multiple acoustic displays on a daily basis (hundreds of thousands over the 21-month period) to determine the acoustic occurrences and identifications of marine mammals and unique acoustic phenomena.

Marine Mammal Counts: Completed 14,112 counts of whale acoustic occurrences (seven species, four counts per day), for one day out of every 10 days (63 total days) on eight IUSS sensors.

AANA: Archived acoustic recordings from the APADS[6] Ambient Noise Analysis (AANA) system onto secondary data drives for redundancy. Thousands of whale tracks were also archived from the ICP onto electronic media.

Single Channel Recorder: Collected signals from 64 channels of continuous, single-hydrophone, real-time acoustic data. These signals were partially analyzed using Raven software to identify sounds of five cetacean species. Three types of acoustic signals were detected: 1) songs from four species: blue, fin, humpback, and minke whales; 2) calls from six species: blue, Bryde's, fin, humpback, minke, and sei whales; and 3) foraging clicks from sperm whales.

Acoustic Recordings: Identified and archived numerous recordings and developed thousands of tracks for blue, Bryde's, fin, humpback, minke, sei, and sperm whales using the AANA and ICP systems. These recordings and tracks include: 1) songs (blue, fin, humpback, and minke whales); 2) calls (blue, Bryde's, fin, humpback, minke, and sei whales); and 3) foraging clicks (from sperm whales) recorded throughout the year. The recordings and tracks are from a wide variety of locations and under a range of behavioral contexts (e.g., summer foraging in areas of high prey productivity, migratory movements, or meandering travel throughout an area for weeks at a time).

SURTASS Analyst Training Sessions: Conducted six days of acoustic training sessions for SURTASS ship-riding personnel at NOPF Whidbey Island, WA. Some students were from the fixed IUSS community; approximately 200 students attended.

[4] The Integrated Common Processor (ICP) has the capability to process and display data from all IUSS fixed and mobile underwater systems, taking advantage of automation advancement, array technology improvements, hardware insertions, and the common software components of the Navy's submarine and surface undersea warfare systems.
[5] Raven is a software program for the acquisition, visualization, measurement, and analysis of acoustics signals.
[6] APADS is the Acoustic Processing and Display System.

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Humpback Whales: In the 21 months covered by this report, M3 generated 1,629 tracks with 9,251 positions of humpback whales, focusing on the variability of swimming speeds while the whales were singing and while not singing. This report covers two humpback whale migrations, January to April 2017 and November to April 2018. The humpback whale tracks from these acoustic seasons will be compared with previous years of humpback tracks and combined into a science paper for submission to a peer-reviewed scientific journal. In preparation for this scientific paper, 438 tracks from the last ten years were selected and entered into an Excel spreadsheet database. This database contains 6,939 positions in which humpback whales swam a total of 54,768 nautical miles (nm) and reveals a wide range of singing and non-singing swim speeds.

Sei Whales: Generated 260 tracks with 1,154 positions of sei whales. These tracking reports provide valuable information on annual movements, behaviors, vocalizations, and distribution of a rarely-observed, largely oceanic marine mammal. The distribution of the sei whale is poorly understood because they are visually difficult to differentiate from either Bryde's or fin whales at sea, exhibit unpredictable occurrence patterns, and occur principally in oceanic regions with only rare occurrence in neritic[7] waters (Jefferson et al., 2008).

Blue Whale: Generated 593 tracks with 6,699 positions of Atlantic blue whales. The capability to acoustically track individual blue whales over long distances provides valuable information on individual whale movement, reproductive behavior, and song variability. Individual Atlantic blue whale singers sometimes include such a unique set of song features that the singer can be recognized in a different basin after being lost for days. Blue whales are known to produce regionally distinct songs. At least 13 blue whale songs have been documented in the world. To date, M3 has identified regionally distinct blue whale songs from the North Atlantic, Western North Pacific, Eastern North Pacific, Antarctic, North Indian Ocean (Sri Lanka), and pygmy blue whale. M3 also has two blue whale song forms (referred to as Namibia and Cape Verde dialects) that have yet to be associated with documented blues.

Western Pacific Blue Whale: Two individual Western Pacific blue whale singers were detected and tracked during the acoustic season (2017 and 2018). Since 2016, these two Western Pacific blue whales were successfully identified from other blue whales due to their unique acoustic signatures. Referred to as “Gap” and “No-Gap,” these two whales display strong mid-spectrum frequency modulation and weak mating song. On 15 August 2018, Gap was regained as whale number WPAC-Blue-02-Aug18 in the Northwest Pacific. It is still being tracked as M3 completes this report. In 2017, Gap was held as whale number WPAC-Blue-03-Aug17 and tracked for 129 days. In 2016, Gap was detected as whale number WPAC-Blue-13-Aug16 and tracked for 197 days. On 25 July 2018, No-Gap was detected with a very strong mid-spectrum song in the Northwest Pacific. It is being tracked as whale number WPAC-Blue-01-Jul18, and it is also being held as this report is wrapped up. In 2017, No-Gap was gained on 20 August 2017, and tracked as whale number WPAC-Blue-04-Aug17 for 84 days. In 2016, No-Gap was detected on 24 July and tracked as whale number WPAC-Blue-11-Jul16 for 152 days. These two whales, Gap and No-Gap, provide a unique insight into the mating area, habit, and possible feeding areas of Western blue whales. Gap and No-Gap have been tracked on occasion in very close proximity to each other (<35 nm between the two individuals).

Atlantic Hybrid Whale: In the 21 months covered by this report, detected and tracked a unique acoustic signature believed to be a hybrid of a blue and fin whale, which the M3 program refers to as "Bluefin"

[7] The neritic zone is the shallow marine environment extending from mean low water down to 200-meter (660-foot) depths, generally corresponding to the continental shelf.

because the acoustic features of its song are a combination of both blue and fin whale song features. The Bluefin's migration tracks during 2017 and 2018 resembled that of 2010, 2014, 2015, and 2016. The track for Bluefin in 2018 began a few hundred miles further east than it did in 2017. Bluefin was noted increasing his swim speed to over 7 knots, and reducing his song duty-cycle when he moved into bad weather in September 2018. In the North Atlantic Ocean, this Bluefin whale has been recorded and tracked annually for at least a decade, typically following a similar pattern of movements each year. In 2018, Bluefin came very close to multiple sensors, providing the best acoustic signature of the last several years. This unique collection of data and analysis reports has added to the growing understanding of the movement patterns and behaviors of large baleen whales acoustically, spatially and temporally.

Pacific Hybrid Whale: In November 2017, for the first time, M3 personnel noted a Bluefin signature in the Pacific Ocean. The bandwidth of the pulses of the Pacific Bluefin is slightly higher than the bandwidth for the Atlantic Bluefin (18-20Hz versus 15.5-19Hz). This slight disparity makes sense since the Western Blue Whale song is about 1.5Hz higher in frequency than the Atlantic Blue Whale song.

Fin Whale: Generated 1,812 tracks with 9,932 positions of fin whales. Several singing fin whales, whose songs had very distinctive features, were detected and tracked over many days. Preliminary analysis of this large amount of data and resultant analysis reports on fin whale singers in the Atlantic Ocean suggest that no specific breeding area exists in the Atlantic Ocean for fin whales, and that they may breed opportunistically both temporally and spatially.

Sperm Whale: Generated 198 tracks of sperm whales with 879 positions. Sperm whale clicks were originally thought to be too high in frequency to be detected by IUSS assets. It has been determined, however, that sufficient energy on the lower-frequency side of the click frequency band makes these whales very detectable when they are relatively close to an IUSS sensor.

Western Gray Whale: Updated a memorandum that discusses SURTASS-derived detections of acoustic signatures believed to be originating from western gray whales. These sounds are detected in shallow water of the South China Sea, East China Sea, and Sea of Japan, and indicate an area of wintering for these highly-endangered marine mammals. The initial report on these whale detections was generated in 2016 after approval by CUS and OPNAV N2N6F24, and was released to Dr. Brandon Southall, who serves on an advisory committee of the International Union for Conservation of Nature (IUCN). The updated 2018 memorandum contains acoustic displays and adds another shallow water area of detection.

Omura's Whale: M3 had monitored an unknown whale vocalization at 20 Hertz for several years in both the South China Sea and East China Sea. In 2017 with the help of Dr. Cerchio, M3 identified these vocalizations as those from the Omura's whale (Cerchio et al. 2015). During this reporting timeframe, and depending whether SURTASS was present or not, Omura's whales were detected in every month but April in the South China Sea. In the East China Sea, Omura's were detected in Jan, Feb, Mar, Sept, Oct, and Dec.

Bryde's Whale: Detected several Bryde's whales in near-equatorial waters in August and September in both 2017 and 2018. These whales emit a low source level song and fixed or SURTASS arrays must be close aboard to detect them. Bryde's whales were detected in both the Pacific Ocean and Atlantic Ocean up to latitude 30° N.

Sea of Japan Fin Whale: M3 has observed a distinct, higher than normal fin whale song in the Sea of Japan (SOJ). These songs are unique and as many as four individuals have been observed vocalizing at one time. An acoustic recording was requested and is awaiting analysis by senior scientist personnel to confirm M3 analysts' initial classification.

Chatter: An observation made by M3 may equate to a new element of discovery of marine mammal vocalizations. The observation is that several species of baleen whale have been noted to have song and song elements that are erratic in frequency and time. M3 believes these observations are early season songs from whales that haven't going into a complete "rut" and are producing a synthetic, or plastic, song. Chatter has been noted from minke, humpback, Bryde's, western gray, and sei whales. It is possible that chatter is also produced by fin and blue whales. The importance to the Navy regarding chatter is that chatter exists in a natural environment and is not caused by active sonar or other anthropogenic activities. Acoustic information on chatter will be assembled and documented in a forthcoming scientific paper.

SURTASS Marine Mammal Detections: In 2017 and 2018, daily monitoring of SURTASS arrays when deployed revealed thousands of hours of marine mammal detection for at least eight different species. In 2018, SURTASS missions were recorded to document mission, mission area, wet array time, whale holding hours[8], and species held. Not all arrays were able to be monitored due to current software incompatibility. Over the next few months, a software upgrade will allow M3 to monitor all arrays.

The following was gathered for the first three quarters of 2018:

X911
Deployed to four different geographic areas. M3 detected 169 whales from six different species (humpback, fin, sperm, Bryde's, Omura's, Western Gray Whale). X911 had 1,845.5 hours of array wet time on ICP. M3 detected 3,397.7 whale hours* on array X911 in 2018.

X011
Deployed to six different geographic areas. M3 detected 206 whales from eight different species (humpback, fin, sperm, Bryde's, Omura's, Western Gray Whale, blue, and unknown). X011 had 1,782.7 hours of array wet time on ICP. M3 detected 1,637.8 whale hours* on X011 in 2018.

X111
Deployed to five different geographic areas. M3 detected 191 whales from four different species (humpback, sperm, Bryde's, Omura's). X111 had 1,756.0 hours of array wet time on ICP. M3 detected 1,261.4 whale hours on X111 in 2018.

X211
Deployed to three different geographic areas. M3 detected 93 whales from two different species (humpback, Omura's). X211 had 1,875.8 hours of array wet time on ICP. M3 detected 882.3 whale hours on X211 in 2018.

5 SURTASS LFA SONAR TRAINING IN 2017-FY18

From 20 through 21 June 2017, 21 through 22 September 2017, and 8 through 9 March 2018, senior marine acoustician, Dorene Stevenson, from MAI, conducted passive acoustic training for the USNS

[8] "Whale-holding hours" or "whale hours" equals the number of whales held (detected) times the number of hours held. For example, if two fin whales were held for three hours, that equates to six whale hours held.

VICTORIOUS, USNS ABLE, USNS EFFECTIVE, USNS LOYAL, and USNS IMPECCABLE at NOPF Whidbey Island, WA. The passive acoustic trainings consisted of a classified Microsoft PowerPoint presentation. The presentation included: 1) an introductory component that covered the requirements of passive acoustic monitoring for marine mammal species specified under permits and/or the NDE for LFA sonar employment; 2) a marine mammal identification component that described basic information about the primary marine mammal species that may be detected on SURTASS, and species-specific acoustic characteristics for visual identification on spectrograms during passive acoustic monitoring; and 3) recommended sonar display parameters to facilitate the detection and identification of acoustically active marine mammal species.

The introductory component included an overview of the reasons why monitoring mitigation of marine species is conducted during SURTASS LFA sonar transmissions, the monitoring requirements and procedures per the LOAs/NDE and Endangered Species Act (ESA) Incidental Take Statement (ITS) permits, and the importance of this task to the Navy's continued ability to use SURTASS LFA sonar. The other types of monitoring mitigation required during SURTASS LFA sonar transmissions, visual monitoring and active acoustic monitoring with the High-Frequency Marine Mammal Monitoring (HF/M3) sonar, were also discussed. Passive acoustic reporting procedures were discussed, with the explanation of how the information the MILCREW collects is reported to other Navy organizations and ultimately to the federal regulator, NMFS, which authorizes the Navy to use SURTASS LFA sonar.

The marine mammal identification component of the training included basic information about the species of marine mammals they could detect on the SURTASS passive array. The migratory and vocalization behavior of each marine mammal species was described, as well as key features on exemplar spectrograms that can be used to identify each species. The parameters of the sonar display were discussed, with recommended settings to aid with classifying detected biological signals to a specific marine mammal species. Many of the settings that are used by sonar operators at NOPF Dam Neck for review of SOSUS and SURTASS data for marine mammals are different from those typically used for mission-directed sonar operations.

6 FUTURE GOALS OF M3 PROGRAM

Several of the future plans for the M3 program are infra-structure related with hardware and software upgrades, an extension of the NOPF building, and the acquisition of additional equipment being top priorities. An expansion and augmentation of the M3 program are highly desirable, as an expanded capability would facilitate the transition into the public domain of vitally important reports and information on marine mammal movements, distributions, and bioacoustic behaviors that the M3 program has derived.

The following are immediate and long-term goals of the M3 Program:

- Increase the number of single-hydrophone inputs and upgrade the Raven software acquisition system to enable recording from one hydrophone for every available IUSS sensor, with the capability of adding additional sensors. This software and hardware upgrade is being developed by Lockheed Martin, the primary Raven software engineer at Cornell and M3 scientists. This upgrade will be delivered to M3 with the next ICP installation for IUSS systems.
- Use the upgraded NOPF APADS for storage of all CSM data. NOPF APADS is being developed by ARL: UT and Lockheed Martin, and will be delivered to M3 with the next ICP installation for IUSS systems.

- Expand data collection and analysis to include calibrated measurements of received levels of species-specific sounds and calculations of source levels of marine animal sounds and detection ranges. These data are part of the input needed to derive probability of detection (PoD) functions for passive acoustic data for different marine mammal species. These metrics are essential inputs for estimating acoustic population densities, as well as data that document species-specific sound production rates. Marine mammal density estimates are critical for quantifying the impact of anthropogenic sound on individual species or population stocks.
- Expand data collection and analysis to include calibrated measurements of anthropogenic noise sources (e.g., surface vessels and seismic airgun surveys). This expansion would include calculations of received levels, source levels, and spatial-temporal dynamics of the resultant acoustic environment (i.e., acoustic footprints).
- Double the M3 program workspace to accommodate space for the Non-secure Internet Protocol Router (NIPR), the Secure Internet Protocol Router Network (SIPRNet), a potential additional ICP console, an administrative computer, NOPF APADS, and a briefing area.
- Move the software acquisition system for Raven from downstairs to upstairs in the M3 program spaces and expand data processing software to include real-time, automated detection-classification of acoustically active whale species and a suite of visual summaries of species-specific detection statistics.
- Work within Navy security classification guidelines to generate reports of scientific findings and submit the reports for declassification and ultimate publication in peer-reviewed scientific journals.

7 LITERATURE CITED

Cerchio, S., B. Andrianantenaina, A. Lindsay, M. Rekdahl, N. Andrianarivelo, and T. Rasoloarijao. 2015. Omura's whales (*Balaenoptera omurai*) off northwest Madagascar: ecology, behaviour and conservation needs. Royal Society Open Science 2:150301. http://dx.doi.org/150310.151098/rsos.150301.

Clark, C.W. and K.M. Fristrup. 1997. Whales '95: A combined visual and acoustic survey of blue and fin whales off southern California. Reports of the International Whaling Commission 47:583-600.

Clark, C.W. and G.C. Gagnon. 2002. Low-frequency vocal behaviors of baleen whales in the North Atlantic: Insights from IUSS detections, locations and tracking from 1992 to 1996. J. Underwater Acoust. (USN), 52 (3):609-640.

Clark, C.W., G.C. Gagnon, and A.S. Frankel. In prep. Fin whale singing decreases with increased swimming speed. Royal Society of Open Science.

Costa, D.P. 1993.The secret life of marine mammals. Novel tools for studying their behavior and biology at sea. Oceanography. 6:120-128.

DoN (U.S. Department of the Navy). 2001. Final overseas environmental impact statement and environmental impact statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar. Washington, D.C.: Department of the Navy, Chief of Naval Operations.

Annual Report of the M3 Program

DoN. 2017. Final supplemental environmental impact statement/supplemental overseas environmental impact statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) sonar. Washington, D.C.: Department of the Navy, Chief of Naval Operations.

Fristrup, K., and C.W. Clark. 1997. Combining visual and acoustic survey data to enhance density estimation. Reports of the International Whaling Commission 47:933-936.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: a comprehensive guide to their identification. San Diego, California: Elsevier.

NOAA (National Oceanic and Atmospheric Administration). 2002. Taking and importing marine mammals; taking marine mammals incidental to Navy operations of Surveillance Towed Array Sensor System Low Frequency Active sonar. Final Rule. National Marine Fisheries Service, National Oceanic and Atmospheric Administration. Federal Register 67(136):46712-46789.

Watkins, W. A., Daher, M. A., Reppucci, G. M., George, J. E., Martin, D. L., DiMarzio, N. A., and Gannon, D. P. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13:62–67.

Watkins, W.A., Daher, M.A., Munder, L.A., Hildebrand, J.A., and Moore, S.E. 2004. Twelve years of tracking 52-Hz whale calls from a unique source in the North Pacific. Deep-Sea Research I 51:1889-1901.