REQUEST FOR REGULATIONS AND LETTERS OF AUTHORIZATION

FOR THE INCIDENTAL TAKING OF MARINE MAMMALS RESULTING FROM U.S. NAVY TRAINING AND TESTING ACTIVITIES IN THE HAWAII-SOUTHERN CALIFORNIA TRAINING AND TESTING STUDY AREA

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1 Description of Specified Activity

1.1 Introduction

The United States (U.S.) Department of the Navy (Navy) has prepared this consolidated request for regulations and two Letters of Authorization (LOAs) for the incidental taking (as defined in Chapter 5, Type of Incidental Taking Authorization Requested) of marine mammals during the conduct of training and testing activities within the Hawaii-Southern California Training and Testing (HSTT) Study Area. The Navy is requesting a five-year LOA for training activities and a five-year LOA for testing activities, each proposed to be conducted from December 26, 2018 through December 25, 2023.

Under the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 United States Code § 1371(a)(5)), the Secretary of Commerce shall allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity during periods of not more than five years, if certain findings are made and regulations are issued after notice and opportunity for public comment. The Secretary must find that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The regulations must set forth the permissible methods of taking, other means of effecting the least practicable adverse impact on the species or stock(s), and requirements pertaining to the monitoring and reporting of such taking.

The Navy is preparing an Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) for the HSTT Study Area[1] to evaluate all components of the proposed training and testing activities. A description of the HSTT Study Area (Figure 1-1) and various components is provided in Chapter 2 (Dates, Duration, and Specified Geographic Region). A description of the training and testing activities for which the Navy is requesting incidental take authorizations is provided in the following sections. This request for LOAs is based on the proposed training and testing activities of the Navy's Preferred Alternative (Alternative 1 in the EIS/OEIS, referred to in this document as the Proposed Action).

This document has been prepared in accordance with the applicable regulations of the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (Public Law 108–136) and its implementing regulations. The request for LOAs is based on (1) the analysis of spatial and temporal distributions of protected marine mammals in the HSTT Study Area, (2) the review of training and testing activities analyzed in the HSTT Draft EIS/OEIS that have the potential to incidentally take marine mammals, and (3) a technical risk assessment to determine the likelihood of effects.

This chapter describes those training and testing activities that are likely to result in Level B harassment, Level A harassment, or mortality under the MMPA. Of the Navy activities analyzed for the HSTT Draft EIS/OEIS, the Navy has determined that only the use of sonar and other transducers, air guns, pile driving and removal, and in-water detonations have the potential to affect marine mammals to a level

[1] The HSTT Draft EIS/OEIS (U.S. Department of the Navy, 2017), referred to as the Phase III document, was published in October 2017. That Draft EIS/OEIS updates a previous HSTT Final EIS/OEIS (U.S. Department of the Navy, 2013c) completed in 2013, referred to as the Phase II document. In this LOA application, all references to the HSTT Draft EIS/OEIS will be to the current, Phase III document, unless the 2013 Phase II document is specifically identified.

that would constitute harassment under the MMPA. In addition to these potential impacts from specific activities, the Navy will also request takes from vessel strikes that may occur during any training or testing activities. These takes, however, are not specific to any particular training or testing activity.

1.2 Background

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is mandated by federal law (Title 10 United States Code § 5062), which ensures the readiness of the naval forces of the United States.[2] The Navy executes this responsibility by establishing and executing training programs, including at-sea training and exercises, and ensuring naval forces have access to the ranges, operating areas, and airspace needed to develop and maintain skills for conducting naval activities. Further, the Navy's testing activities ensure naval forces are equipped with well-maintained systems that take advantage of the latest technological advances. The Navy tests ships, aircraft, weapons, combat systems, sensors and related equipment, and conducts scientific research activities to achieve and maintain military readiness.

The Navy is preparing an EIS/OEIS to assess the potential environmental impacts associated with proposed naval training and testing activities in the Study Area. The Navy is the lead agency for the HSTT Draft EIS/OEIS, and National Marine Fisheries Service (NMFS) is a cooperating agency pursuant to 40 Code of Federal Regulations §§ 1501.6 and 1508.5.

In addition, in accordance with section 7(c) of the Endangered Species Act (ESA) of 1973, as amended, the Navy is required to consult with NMFS for those actions it has determined may affect ESA-listed species or critical habitat. The Navy is preparing a Biological Assessment as part of this consultation.

2 Title 10, Section 5062 of the United States Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of Naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with Integrated Joint Mobilization Plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

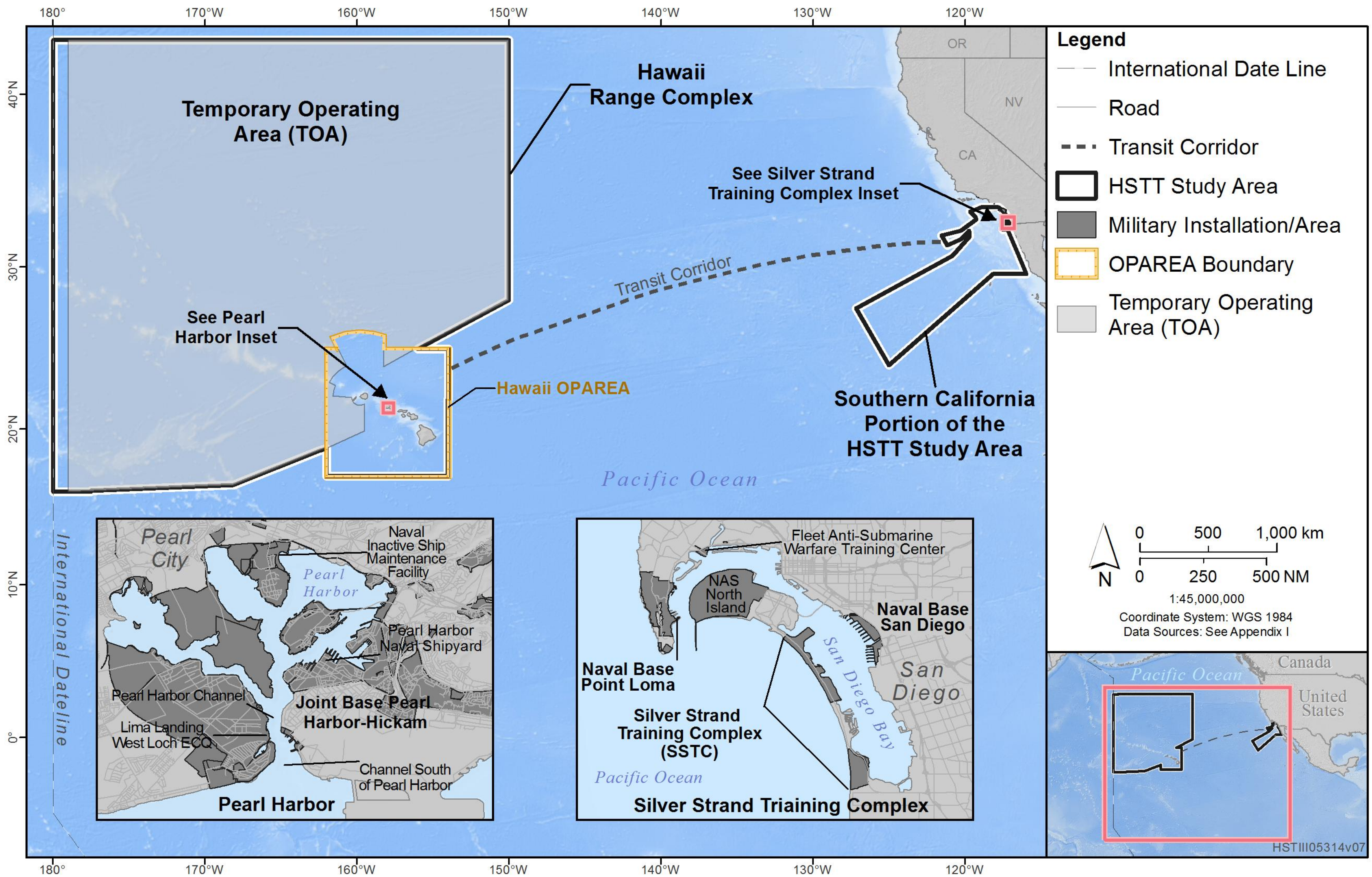

Figure 1-1: Hawaii-Southern California Training and Testing Study Area

Notes: HSTT = Hawaii-Southern California Training and Testing, NAS = Naval Air Station

1.3 Overview of Training and Testing Activities

1.3.1 Primary Mission Areas

The Navy categorizes its activities into functional warfare areas called primary mission areas. These activities generally fall into the following seven primary mission areas:

- air warfare
- amphibious warfare
- anti-submarine warfare
- electronic warfare
- expeditionary warfare
- mine warfare
- surface warfare

Most activities are categorized under one of these primary mission areas; the testing community has three additional categories of activities for vessel evaluation, unmanned systems, and acoustic and oceanographic science and technology. Activities that do not fall within one of these areas are in a separate "other" category. Each warfare community (surface, subsurface, aviation, and special warfare) may train within some or all of these primary mission areas. The research and acquisition community also categorizes most, but not all, of its testing activities under these primary mission areas.

The Navy describes and analyzes the effects of its training and testing activities within the HSTT Draft EIS/OEIS (U.S. Department of the Navy 2017). In its assessment, the Navy concluded that sonar and other transducers, air guns, pile driving and removal, and in-water detonations were the stressors most likely to result in impacts on marine mammals that could rise to the level of harassment as defined under the MMPA. Therefore, this LOA request provides the Navy's assessment of potential effects from these stressors in terms of the various warfare mission areas in which they would be conducted. This includes:

- Amphibious Warfare (in-water detonations)
- Anti-submarine warfare (sonar and other transducers, in-water detonations)
- Mine Warfare (sonar and other transducers, in-water detonations)
- Surface Warfare (in-water detonations)
- Other (sonar and other transducers, air guns, and pile driving and removal)

The Navy's activities in Air Warfare, Electronic Warfare, and Expeditionary Warfare do not involve sonar and other transducers, underwater detonations, pile driving, airguns, or any other stressors that could result in harassment of marine mammals. The activities in these warfare areas are therefore not considered further in this LOA request, but are analyzed fully in the Navy's HSTT Draft EIS/OEIS.

1.3.1.1 Amphibious Warfare

The mission of amphibious warfare is to project military power from the sea to the shore (i.e., attack a threat on land by a military force embarked on ships) through the use of naval firepower and expeditionary landing forces. Amphibious warfare operations include small unit reconnaissance or raid missions to large-scale amphibious exercises involving multiple ships and aircraft combined into a strike group.

Amphibious warfare training ranges from individual, crew, and small unit events to large task force exercises. Individual and crew training include amphibious vehicles and naval gunfire support training.

Such training includes shore assaults, boat raids, airfield or port seizures, and reconnaissance. Large-scale amphibious exercises involve ship-to-shore maneuver, naval fire support, such as shore bombardment, and air strike and attacks on targets that are in close proximity to friendly forces.

Testing of guns, munitions, aircraft, ships, and amphibious vessels and vehicles used in amphibious warfare are often integrated into training activities and, in most cases, the systems are used in the same manner in which they are used for fleet training activities. Amphibious warfare tests, when integrated with training activities or conducted separately as full operational evaluations on existing amphibious vessels and vehicles following maintenance, repair, or modernization, may be conducted independently or in conjunction with other amphibious ship and aircraft activities. Testing is performed to ensure effective ship-to-shore coordination and transport of personnel, equipment, and supplies. Tests may also be conducted periodically on other systems, vessels, and aircraft intended for amphibious operations to assess operability and to investigate efficacy of new technologies.

1.3.1.2 Anti-Submarine Warfare

The mission of anti-submarine warfare is to locate, neutralize, and defeat hostile submarine forces that threaten Navy forces. Anti-submarine warfare is based on the principle that surveillance and attack aircraft, ships, and submarines all search for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack submarine threats.

Anti-submarine warfare training addresses basic skills such as detection and classification of submarines, as well as evaluating sounds to distinguish between enemy submarines and friendly submarines, ships, and marine life. More advanced training integrates the full spectrum of anti-submarine warfare from detecting and tracking a submarine to attacking a target using either exercise torpedoes (i.e., torpedoes that do not contain a warhead) or simulated weapons. These integrated anti-submarine warfare training exercises are conducted in coordinated, at-sea training events involving submarines, ships, and aircraft.

Testing of anti-submarine warfare systems is conducted to develop new technologies and assess weapon performance and operability with new systems and platforms, such as unmanned systems. Testing uses ships, submarines, and aircraft to demonstrate capabilities of torpedoes, missiles, countermeasure systems, and underwater surveillance and communications systems. Tests may be conducted as part of a large-scale fleet training event involving submarines, ships, fixed-wing aircraft, and helicopters. These integrated training events offer opportunities to conduct research and acquisition activities and to train aircrew in the use of new or newly enhanced systems during a large-scale, complex exercise.

1.3.1.3 Mine Warfare

The mission of mine warfare is to detect, classify, and avoid or neutralize (disable) mines to protect Navy ships and submarines and to maintain free access to ports and shipping lanes. Mine warfare also includes offensive mine laying to gain control of or deny the enemy access to sea space. Naval mines can be laid by ships, submarines, or aircraft.

Mine warfare training includes exercises in which ships, aircraft, submarines, underwater vehicles, unmanned vehicles, or marine mammal detection systems search for mine shapes. Personnel train to destroy or disable mines by attaching underwater explosives to or near the mine or using remotely

operated vehicles to destroy the mine. Towed influence mine sweep systems mimic a particular ship's magnetic and acoustic signature, which would trigger a real mine causing it to explode.

Testing and development of mine warfare systems is conducted to improve sonar, laser, and magnetic detectors intended to hunt, locate, and record the positions of mines for avoidance or subsequent neutralization. Mine warfare testing and development falls into two primary categories: mine detection and classification, and mine countermeasure and neutralization testing. Mine detection and classification testing involves the use of air, surface, and subsurface vessels and uses sonar, including towed and side- scan sonar, and unmanned vehicles to locate and identify objects underwater. Mine detection and classification systems are sometimes used in conjunction with a mine neutralization system. Mine countermeasure and neutralization testing includes the use of air, surface, and subsurface units and uses tracking devices, countermeasure and neutralization systems, and general purpose bombs to evaluate the effectiveness of neutralizing mine threats. Most neutralization tests use mine shapes, or non-explosive practice mines, to accomplish the requirements of the activity. For example, during a mine neutralization test, a previously located mine is destroyed or rendered nonfunctional using a helicopter or manned/unmanned surface vehicle based system that may involve the deployment of a towed neutralization system.

A small percentage of mine warfare activities require the use of high-explosive mines to evaluate and confirm the ability of the system or the crews conducting the training to neutralize a high-explosive mine under operational conditions. The majority of mine warfare systems are deployed by ships, helicopters, and unmanned vehicles. Tests may also be conducted in support of scientific research to support these new technologies.

1.3.1.4 Surface Warfare

The mission of surface warfare is to obtain control of sea space from which naval forces may operate, which entails offensive action against surface targets while also defending against aggressive actions by enemy forces. In the conduct of surface warfare, aircraft use guns, air-launched cruise missiles, or other precision-guided munitions; ships employ naval guns and surface-to-surface missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles.

Surface warfare training includes surface-to-surface gunnery and missile exercises; air-to-surface gunnery, bombing, and missile exercises; submarine missile or torpedo launch events; and other munitions against surface targets.

Testing of weapons used in surface warfare is conducted to develop new technologies and to assess weapon performance and operability with new systems and platforms, such as unmanned systems. Tests include various air-to-surface guns and missiles, surface-to-surface guns and missiles, and bombing tests. Testing events may be integrated into training activities to test aircraft or aircraft systems in the delivery of munitions on a surface target. In most cases the tested systems are used in the same manner in which they are used for fleet training activities.

1.3.2 Overview of Training Activities Within the Study Area

The Navy routinely trains in the HSTT Study Area in preparation for national defense missions. Training activities and exercises covered in this request for LOAs are briefly described below, and in more detail within the HSTT Draft EIS/OEIS. Each military training activity described meets a requirement that can be traced ultimately to requirements set forth by the National Command Authority.[3]

A major training exercise is comprised of several "unit level" range exercises conducted by several units operating together while commanded and controlled by a single commander. These exercises typically employ an exercise scenario developed to train and evaluate the strike group in naval tactical tasks. In a major training exercise, most of the operations and activities being directed and coordinated by the strike group commander are identical in nature to the operations conducted during individual, crew, and smaller unit level training events. In a major training exercise, however, these disparate training tasks are conducted in concert, rather than in isolation. Some integrated or coordinated anti-submarine warfare exercises are similar in that they are comprised of several unit level exercises but are generally on a smaller scale than a major training exercise, are shorter in duration, use fewer assets, and use fewer hours of hull-mounted sonar per exercise. These coordinated exercises are conducted under anti-submarine warfare.

Three key factors used to identify and group the exercises are the scale of the exercise, duration of the exercise, and amount of hull-mounted sonar hours modeled/used for the exercise.

Table 1-1 summarizes how major training exercises and smaller integrated/coordinated antisubmarine exercises were binned to differentiate their differences in scale, duration, and sonar hours for the purposes of exercise reporting requirements.

The training activities that are part of the Proposed Action for this LOA request are described in Table 1 7, which include the activity name, a short description of the activity, the number of activities proposed, and locations. Appendix A (Navy Activity Descriptions) of the HSTT DEIS/OEIS provides more detailed descriptions of the activities.

[3] National Command Authority (NCA) is a term used by the United States military and government to refer to the ultimate lawful source of military orders. The term refers collectively to the President of the United States (as commander-in-chief) and the United States Secretary of Defense.

Table 1-1: Major ASW Training Exercises and Integrated/Coordinated Training Analyzed for this MMPA Authorization Request

	Exercise Group	***Description***	***Scale***	***Duration***	***Location***	***Exercise Examples***	***Modeled Hull-mounted Sonar per Exercise***
Major Training Exercises	Large Integrated ASW	Larger-scale, longer duration integrated ASW exercises	Greater than 6 surface ASW units (up to 30 with the largest exercises), 2 or more submarines, multiple ASW aircraft	Generally greater than 10 days	SOCAL PMSR HRC	RIMPAC, COMPTUEX	>500 hours
	Medium Integrated ASW	Medium-scale, medium duration integrated ASW exercises	Approximately 3-8 surface ASW units, at least 1 submarine, multiple ASW aircraft	Generally 4-10 days	SOCAL PMSR HRC	FLEETEX/ SUSTEX, USWEX	100-500 hours
Integrated/Coordinated Training	Small Integrated ASW	Small-scale, short duration integrated ASW exercises	Approximately 3-6 surface ASW units, 2 dedicated submarines, 2-6 ASW aircraft	Generally less than 5 days	SOCAL HRC	SWATT, NUWTAC	50-100 hours
	Medium Coordinated ASW	Medium-scale, medium duration, coordinated ASW exercises	Approximately 2-4 surface ASW units, possibly a submarine, 2-5 ASW aircraft	Generally 3-10 days	SOCAL HRC	SCC	Less than 100 hours
	Small Coordinated ASW	Small-scale, short duration, coordinated ASW exercises	Approximately 2-4 surface ASW units, possibly a submarine, 1-2 ASW aircraft	Generally 2-4 days	SOCAL HRC	ARG/MEU, ID CERTEX/ASW, Group Sail	Less than 50 hours

Notes: ASW = Anti-Submarine Warfare; SOCAL = Southern California Range Complex; PMSR = Point Mugu Sea Range Overlap; HRC = Hawaii Range Complex; RIMPAC = Rim of the Pacific; COMPTUEX = Composite Training Unit Exercise; FLEETEX/SUSTEX = Fleet Exercise/Sustainment Exercise; USWEX = Undersea Warfare Exercise; SWATT = Surface Warfare Advanced Tactical Training; NUWTAC = Naval Undersea Warfare Training Assessment Course; SCC = Submarine Commanders Course; ARG/MEU CERTEX = Amphibious Ready Group/Marine Expeditionary Unit Certification Exercise; ID CERTEX/ASW = Independent Deployer Certification Exercise/Tailored Anti-submarine Warfare Training

1.3.3 Overview of Testing Activities Within the Study Area

Testing activities covered in this LOA request are briefly described below and in more detail within the HSTT Draft EIS/OEIS. Each military testing activity described meets a requirement that can be traced ultimately to requirements set forth by the National Command Authority.

The Navy's research and acquisition community engages in a broad spectrum of testing activities in support of the fleet. These activities include, but are not limited to, basic and applied scientific research and technology development; testing, evaluation, and maintenance of systems (e.g., missiles, radar, and sonar) and platforms (e.g., surface ships, submarines, and aircraft); and acquisition of systems and platforms to support Navy missions and give a technological edge over adversaries. The individual commands within the research and acquisition community included in this request for LOA are Naval Air Systems Command, Naval Sea Systems Command, Office of Naval Research, and Space and Naval Warfare Systems Command.

The Navy operates in an ever-changing strategic, tactical, financially-constrained, and time-constrained environment. Testing activities occur in response to emerging science or fleet operational needs. For example, future Navy experiments to develop a better understanding of ocean currents may be designed based on advancements made by non-government researchers not yet published in the scientific literature. Similarly, future but yet unknown Navy operations within a specific geographic area may require development of modified Navy assets to address local conditions. Such modifications must be tested in the field to ensure they meet fleet needs and requirements. Accordingly, generic descriptions of some of these activities are the best that can be articulated in a long-term, comprehensive document.

Some testing activities are similar to training activities conducted by the fleet. For example, both the fleet and the research and acquisition community fire torpedoes. While the firing of a torpedo might look identical to an observer, the difference is in the purpose of the firing. The fleet might fire the torpedo to practice the procedures for such a firing, whereas the research and acquisition community might be assessing a new torpedo guidance technology, testing it to ensure that the torpedo meets performance specifications and operational requirements.

1.3.3.1 Naval Air Systems Command Testing Activities

Naval Air Systems Command testing activities generally fall in the primary mission areas used by the fleets. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms (e.g., the F-35 Joint Strike Fighter aircraft), weapons, and systems (e.g., newly developed sonobuoys) that will ultimately be integrated into fleet training activities. In addition to the testing of new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of weapons and systems, such as sonobuoys.

The majority of testing activities conducted by Naval Air Systems Command are similar to fleet training activities, and many platforms and systems currently being tested are already being used by the fleet or will ultimately be integrated into fleet training activities. However, some testing activities may be conducted in different locations and in a different manner than similar fleet training activities, and, therefore, the analysis for those events and the potential environmental effects may differ. Training with systems and platforms delivered to the fleet within the timeframe of this document are analyzed in the training sections of this LOA request.

1.3.3.2 Naval Sea Systems Command Testing Activities

Naval Sea Systems Command activities are generally aligned with the primary mission areas used by the fleets. Additional activities include, but are not limited to, vessel evaluation, unmanned systems, and other testing activities. In this LOA request, pierside testing at Navy and contractor shipyards consists only of system testing.

Testing activities are conducted throughout the life of a Navy ship, from construction through deactivation from the fleet, to verification of performance and mission capabilities. Activities include pierside and at-sea testing of ship systems, including sonar, acoustic countermeasures, radars, torpedoes, weapons, unmanned systems, and radio equipment; tests to determine how the ship performs at sea (sea trials); development and operational test and evaluation programs for new technologies and systems; and testing on all ships and systems that have undergone overhaul or maintenance.

1.3.3.3 Office of Naval Research Testing Activities

As the Department of the Navy’s science and technology provider, the Office of Naval Research provides technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security. The Office of Naval Research manages the Navy’s basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation. The Office of Naval Research is also a parent organization for the Naval Research Laboratory, which operates as the Navy’s corporate research laboratory and conducts a broad multidisciplinary program of scientific research and advanced technological development. Testing conducted by the Office of Naval Research in the HSTT Study Area includes acoustic and oceanographic research, large displacement unmanned underwater vehicle (innovative naval prototype) research, and emerging mine countermeasure technology research.

1.3.3.4 Space and Naval Warfare Systems Command Testing Activities

Space and Naval Warfare Systems Command is the information warfare systems command for the U.S. Navy. The mission of the Space and Naval Warfare Systems Command is to acquire, develop, deliver, and sustain decision superiority for the warfighter. Space and Naval Warfare Systems Command Systems Center Pacific is the research and development part of Space and Naval Warfare Systems Command focused on developing and transitioning technologies in the area of command, control, communications, computers, intelligence, surveillance, and reconnaissance. Space and Naval Warfare Systems Command Systems Center Pacific conducts research, development, test, and evaluation projects to support emerging technologies for intelligence, surveillance, and reconnaissance; anti-terrorism and force protection; mine countermeasures; anti-submarine warfare; oceanographic research; remote sensing; and communications. These activities include, but are not limited to, the testing of surface and subsurface vehicles; intelligence, surveillance, and reconnaissance/information operations sensor systems; underwater surveillance technologies; and underwater communications.

1.4 Description of Acoustic and Explosive Stressors

The Navy uses a variety of sensors, platforms, weapons, and other devices, including ones used to ensure the safety of Sailors and Marines, to meet its mission. Training and testing with these systems may introduce sound and energy into the environment. The proposed training and testing activities were evaluated to identify specific components that could act as stressors by having direct or indirect impacts on the environment. This analysis included identification of the spatial variation of the identified stressors. The following subsections describe the acoustic and explosive stressors for biological resources within the Study Area in detail. A preliminary analysis identified the stressor/resource interactions that warrant further analysis in the LOA application based on public comment received during scoping, previous National Environmental Policy Act (NEPA) analyses, and opinions of subject matter experts. Stressor/resource interactions that were determined to have negligible or no impacts (i.e., vessel, aircraft, weapons noise, and explosions in air) were not carried forward for analysis in the LOA.

1.4.1 Acoustic Stressors

This section describes the characteristics of sounds produced during Navy training and testing. This provides the basis for analysis of acoustic impacts on resources in the remainder of Chapter 6 (Take Estimates for Marine Mammals). Explanations of the terminology and metrics used when describing sound in this LOA application are in Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS. Acoustic stressors include acoustic signals emitted into the water for a specific purpose, such as sonar, other transducers (devices that convert energy from one form to another—in this case, to sound waves), and air guns, as well as incidental sources of broadband sound produced as a byproduct of impact pile driving and vibratory extraction. Explosives also produce broadband sound but are characterized separately from other acoustic sources due to their unique hazardous characteristics (see Section 1.4.2, Explosive Stressors). Characteristics of each of these sound sources are described in the following sections. In order to better organize and facilitate the analysis of approximately 300 sources of underwater sound used for training and testing by the Navy including sonars, other transducers, air guns, and explosives, a series of source classifications, or source bins, were developed. The source classification bins do not include the broadband sounds produced incidental to pile driving, vessel and aircraft transits, and weapons firing and bow shocks.

The use of source classification bins provides the following benefits:

- provides the ability for new sensors or munitions to be covered under existing authorizations, as long as those sources fall within the parameters of a “bin;”
- improves efficiency of source utilization data collection and reporting requirements anticipated under the MMPA authorizations;
- ensures a precautionary approach to all impact estimates, as all sources within a given class are modeled as the most impactful source (highest source level, longest duty cycle, or largest net explosive weight) within that bin;
- allows analyses to be conducted in a more efficient manner, without any compromise of analytical results; and
- provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total numbers of takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training and testing requirements, which are linked to real world events.

1.4.1.1 Sonar and Other Transducers

Active sonar and other transducers emit non-impulsive sound waves into the water to detect objects, safely navigate, and communicate. Passive sonars differ from active sound sources in that they do not emit acoustic signals; rather, they only receive acoustic information about the environment, or listen. In this LOA request, the terms sonar and other transducers will be used to indicate active sound sources unless otherwise specified.

The Navy employs a variety of sonars and other transducers to obtain and transmit information about the undersea environment. Some examples are mid-frequency hull-mounted sonars used to find and track enemy submarines; high frequency small object detection sonars used to detect mines; high frequency underwater modems used to transfer data over short ranges; and extremely high-frequency (> 200 kilohertz [kHz]) Doppler sonars used for navigation, like those used on commercial and private vessels. The characteristics of these sonars and other transducers, such as source level, beam width, directivity, and frequency, depend on the purpose of the source. Higher frequencies can carry more information or provide more information about objects off which they reflect, but attenuate more rapidly. Lower frequencies attenuate less rapidly, so may detect objects over a longer distance, but with less detail.

Propagation of sound produced underwater is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location will be different than near the source due to the interaction of many factors, including propagation loss; how the sound is reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher frequency sounds propagate. The effects of these factors are explained in Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the Study Area.

The sound sources and platforms typically used in naval activities analyzed in this LOA request are described in Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS. Sonars and other transducers used to obtain and transmit information underwater during Navy training and testing activities generally fall into several categories of use described below.

1.4.1.1.1 Anti-Submarine Warfare

Sonar used during anti-submarine warfare would impart the greatest amount of acoustic energy of any category of sonar and other transducers analyzed in this LOA request. Types of sonars used to detect enemy vessels include hull-mounted, towed, line array, sonobuoy, helicopter dipping, and torpedo sonars. In addition, acoustic targets and decoys (countermeasures) may be deployed to emulate the sound signatures of vessels or repeat received signals.

Most anti-submarine warfare sonars are mid-frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets with distance over which threats can be identified. However, some sources may use higher or lower frequencies. Duty cycles can vary widely, from rarely used to continuously active. For example, a submarine‘s mission revolves around its stealth; therefore, submarine sonar is used infrequently because its use would also reveal a submarine’s location. Anti-submarine warfare sonars can be wide-angle in a search mode or highly directional in a track mode.

Most anti-submarine warfare activities involving submarines or submarine targets would occur in waters greater than 600 feet (ft.) deep due to safety concerns about running aground at shallower depths. Sonars used for anti-submarine warfare activities would typically be used beyond 3 nautical miles (NM) from shore. Exceptions include use of dipping sonar by helicopters; maintenance of systems while in port; and system checks while transiting to or from port.

1.4.1.1.2 Mine Warfare, Small Object Detection, and Imaging

Sonars used to locate mines and other small objects, as well those used in imaging (e.g., for hull inspections or imaging of the seafloor), are typically high frequency or very high frequency. Higher frequencies allow for greater resolution and, due to their greater attenuation, are most effective over shorter distances. Mine detection sonar can be deployed (towed or vessel hull-mounted) at variable depths on moving platforms (ships, helicopters, or unmanned vehicles) to sweep a suspected mined area. Hull-mounted anti-submarine sonars can also be used in an object detection mode known as "Kingfisher" mode. Sonars used for imaging are usually used in close proximity to the area of interest, such as pointing downward near the seafloor.

Mine detection sonar use would be concentrated in areas where practice mines are deployed, typically in water depths less than 200 ft. and at established training minefields or temporary minefields close to strategic ports and harbors. Kingfisher mode on vessels is most likely to be used when transiting to and from port. Sound sources used for imaging could be used throughout the Study Area.

1.4.1.1.3 Navigation and Safety

Similar to commercial and private vessels, Navy vessels employ navigational acoustic devices including speed logs, Doppler sonars for ship positioning, and fathometers. These may be in use at any time for safe vessel operation. These sources are typically highly directional to obtain specific navigational data.

1.4.1.1.4 Communication

Sound sources used to transmit data (such as underwater modems), provide location (pingers), or send a single brief release signal to bottom-mounted devices (acoustic release) may be used throughout the Study Area. These sources typically have low duty cycles and are usually only used when it is desirable to send a detectable acoustic message.

1.4.1.1.5 Classification of Sonar and Other Transducers

Sonars and other transducers are grouped into classes that share an attribute, such as frequency range or purpose. Classes are further sorted into bins based on the frequency or bandwidth; source level; and, when warranted, the application in which the source would be used, as follows:

- Frequency of the non-impulsive acoustic source
    - Low-frequency sources operate below 1 kHz
    - Mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz
    - High-frequency sources operate above 10 kHz, up to and including 100 kHz
    - Very high frequency sources operate above 100 kHz but below 200 kHz
- Sound pressure level
    - Greater than 160 dB re 1 µPa, but less than 180 dB re 1 µPa
    - Equal to 180 dB re 1 µPa and up to 200 dB re 1 µPa
    - Greater than 200 dB re 1 µPa

- Application in which the source would be used
  - Sources with similar functions that have similar characteristics, such as pulse length (duration of each pulse), beam pattern, and duty cycle

The bins used for classifying active sonars and transducers that are quantitatively analyzed in the Study Area are shown in Table 1-2. While general parameters or source characteristics are shown in the table, actual source parameters are classified.

Table 1-2: Sonar and Transducers Quantitatively Analyzed

Source Class Category	*Bin*	*Description*
Low-Frequency (LF): Sources that produce signals less than 1 kHz	LF3	LF sources greater than 200 dB
	LF4	LF sources equal to 180 dB and up to 200 dB
	LF5	LF sources less than 180 dB
	LF6	LF sources greater than 200 dB with long pulse lengths
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 – 10 kHz	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)
	MF1K	Kingfisher mode associated with MF1 sonars
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)
	MF5	Active acoustic sonobuoys (e.g., DICASS)
	MF6	Active underwater sound signal devices (e.g., MK84)
	MF8	Active sources (greater than 200 dB) not otherwise binned
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%
	MF14	Oceanographic MF sonar
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 – 100 kHz	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	HF3	Other hull-mounted submarine sonars (classified)
	HF4	Mine detection, classification, and neutralization sonar (e.g., AN/SQS-20)
	HF5	Active sources (greater than 200 dB) not otherwise binned
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)
Very High-Frequency Sonars (VHF): Non-tactical sources that produce signals between 100 – 200 kHz	VHF1	VHF sources greater than 200 dB

Table 1-2: Sonar and Transducers Qualitatively Quantitatively Analyzed (continued)

Source Class Category	*Bin*	*Description*
Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic counter-measures systems) used during ASW training and testing activities	ASW1	MF systems operating above 200 dB
	ASW2	MF Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)
	ASW3	MF towed active acoustic countermeasure systems (e.g., AN/SLQ-25)
	ASW4	MF expendable active acoustic device countermeasures (e.g., MK 3)
	ASW5	MF sonobuoys with high duty cycles
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes	TORP1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)
	TORP2	Heavyweight torpedo (e.g., MK 48)
	TORP3	Heavyweight torpedo (e.g., MK 48)
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars used for ship navigation and safety	FLS2	HF sources with short pulse lengths, narrow beam widths, and focused beam patterns
Acoustic Modems (M): Systems used to transmit data through the water	M3	MF acoustic modems (greater than 190 dB)
Swimmer Detection Sonars (SD): Systems used to detect divers and sub- merged swimmers	SD1 – SD2	HF and VHF sources with short pulse lengths, used for the detection of swimmers and other objects for the purpose of port security
Synthetic Aperature Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS1	MF SAS systems
	SAS2	HF SAS systems
	SAS3	VHF SAS systems
	SAS4	MF to HF broadband mine countermeasure sonar
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes	BB1	MF to HF mine countermeasure sonar
	BB2	HF to VHF mine countermeasure sonar
	BB4	LF to MF oceanographic source
	BB5	LF to MF oceanographic source
	BB6	HF oceanographic source
	BB7	LF oceanographic source

Notes: ASW: Antisubmarine Warfare; BB: Broadband Sound Sources; FLS: Forward Looking Sonar; HF: High-Frequency; LF: Low-Frequency; M: Acoustic Modems; MF: Mid-Frequency; SAS: Synthetic Aperature Sonars; SD: Swimmer Detection Sonars; TORP: Torpedoes; VHF: Very High-Frequency.

1.4.1.2 Air Guns

Air guns are essentially stainless steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water. Small air guns with capacities up to 60 cubic inches would be used during testing activities in the off-shore areas of the Southern California Range Complex and in the Hawaii Range Complex. Table 1-13 shows the number of air guns shots proposed in the HSTT Study Area.

Generated impulses would have short durations, typically a few hundred milliseconds, with dominant frequencies below 1 kHz. The root-mean-square sound pressure level (SPL) and peak pressure (SPL peak) at a distance 1 m from the air gun would be approximately 215 dB re 1 µPa and 227 dB re 1 µPa, respectively, if operated at the full capacity of 60 cubic inches. The size of the air gun chamber can be adjusted, which would result in lower SPLs and sound exposure level (SEL) per shot.

Table 1-3: Training and Testing Air Gun Sources Quantitatively Analyzed In The Study Area

Source Class Category	***Bin***	***Unit***[1]	***Training***				***Testing***			
			Alternative 1		***Alternative 2***		***Alternative 1***		***Alternative 2***	
			Annual	***5-year Total***	***Annual***	***5-year Total***	***Annual***	***5-year Total***	***Annual***	***5-year Total***
Air Guns (AG): small underwater air guns	AG	C	0	0	0	0	284	1,420	284	1,420

[1] C = count. One count (C) of AG is equivalent to 100 air gun firings.

1.4.1.3 Pile Driving

Impact pile driving and vibratory pile removal would occur during construction of an Elevated Causeway System, a temporary pier that allows the offloading of ships in areas without a permanent port. Construction of the elevated causeway could occur in sandy shallow water coastal areas at Silver Strand Training Complex and at Camp Pendleton, both in the Southern California Range Complex.

Installing piles for elevated causeways would involve the use of an impact hammer mechanism with both it and the pile held in place by a crane. The hammer rests on the pile, and the assemblage is then placed in position vertically on the beach or, when offshore, positioned with the pile in the water and resting on the seafloor. When the pile driving starts, the hammer part of the mechanism is raised up and allowed to fall, transferring energy to the top of the pile. The pile is thereby driven into the sediment by a repeated series of these hammer blows. Each blow results in an impulsive sound emanating from the length of the pile into the water column as well as from the bottom of the pile through the sediment. Because the impact wave travels through the steel pile at speeds faster than the speed of sound in water, a steep-fronted acoustic shock wave is formed in the water (note this shock wave has very low peak pressure compared to a shock wave from an explosive) (Reinhall & Dahl, 2011). An impact pile driver generally operates on average 35 blows per minute.

Pile removal involves the use of vibratory extraction, during which the vibratory hammer is suspended from the crane and attached to the top of a pile. The pile is then vibrated by hydraulic motors rotating eccentric weights in the mechanism, causing a rapid up and down vibration in the pile. This vibration causes the sediment particles in contact with the pile to lose frictional grip on the pile. The crane slowly lifts up on the vibratory driver and pile until the pile is free of the sediment. Vibratory removal creates continuous non-impulsive noise at low source levels for a short duration.

The source levels of the noise produced by impact pile driving and vibratory pile removal from an actual elevated causeway pile driving and removal are shown in Table 1-4.

Table 1-4: Elevated Causeway System Pile Driving and Removal Underwater Sound Levels

Pile Size &Type	*Method*	*Average Sound Levels at 10 m (SEL per individual pile)*
24-in. Steel Pipe Pile	Impact[1]	192 dB re 1 µPa SPL peak 182 dB re 1 $\mu Pa^2 s$ SEL (single strike)
24-in. Steel Pipe Pile	Vibratory[2]	146 dB re 1 µPa SPL rms 145 dB re 1 $\mu Pa^2 s$ SEL (per second of duration)

[1]Illingworth and Rodkin (2016), [2]Illingworth and Rodkin (2015)
Notes: in. = inch, SEL = Sound Exposure Level, SPL = Sound Pressure Level, rms = root mean squared, dB re 1 µPa = decibels referenced to 1 micropascal

In addition to underwater noise, the installation and removal of piles also results in airborne noise in the environment. Impact pile driving creates in-air impulsive sound about 100 dBA re 20 µPa at a range of 15 m (Illingworth and Rodkin, 2015, 2016). During vibratory extraction, the three aspects that generate airborne noise are the crane, the power plant, and the vibratory extractor. The average sound level recorded in air during vibratory extraction was about 85 dBA re 20 µPa (94 dB re 20 µPa) within a range of 10 to 15 m (Illingworth and Rodkin, 2015). The length of the pier, and therefore the number of piles required, would be determined by the distance from shore to the appropriate water depth for ship off-loading. During training exercises, Elevated Causeway System construction is continued until personnel become proficient in the operation of the pile driving equipment and construction techniques. The size of the pier and number of piles used in an ELCAS event is assumed to be no greater than 1,520 feet long, requiring 119 supporting piles. Construction of the Elevated Causeway System would involve intermittent impact pile driving over approximately 20 days. Crews work 24 hours a day and would drive approximately six piles in that period. Each pile takes about 15 minutes to drive with time taken between piles to reposition the driver. When training events that use the Elevated Causeway System are complete, the structure would be removed using vibratory methods over approximately 10 days. Crews would remove about 12 piles per 24-hour period, each taking about six minutes to remove. Table 1-5 summarizes pile driving activitiy.

Pile driving for elevated causeway system training would occur in shallower water, and sound could be transmitted on direct paths through the water, be reflected at the water surface or bottom, or travel through bottom substrate. Soft substrates such as sand bottom at the proposed elevated causeway system locations would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave. Most acoustic energy would be concentrated below 1,000 hertz (Hz) (Hildebrand, 2009).

Table 1 5: Summary of Pile Driving and Removal Activities per 24-Hour Period

Method	Piles Per 24-Hour Period	Time Per Pile	Total Estimated Time of Noise Per 24-Hour Period
Pile Driving (Impact)	6	15 minutes	90 minutes
Pile Removal (Vibratory)	12	6 minutes	72 minutes

1.4.2 EXPLOSIVE STRESSORS

This section describes the characteristics of explosions during naval training and testing. The activities analyzed in the LOA request that use explosives are described in Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS. Explanations of the terminology and metrics used when describing explosives in this LOA application are in Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS.

The near-instantaneous rise from ambient to an extremely high peak pressure is what makes an explosive shock wave potentially damaging. Farther from an explosive, the peak pressures decay and the explosive waves propagate as an impulsive, broadband sound. Several parameters influence the effect of an explosive: the weight of the explosive warhead, the type of explosive material, the boundaries and characteristics of the propagation medium, and, in water, the detonation depth. The net explosive weight, the explosive power of a charge expressed as the equivalent weight of trinitrotoluene (TNT), accounts for the first two parameters. The effects of these factors are explained in Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS.

1.4.2.1 Explosions in Water

Explosive detonations during training and testing activities are associated with high-explosive munitions, including, but not limited to, bombs, missiles, rockets, naval gun shells, torpedoes, mines, demolition charges, and explosive sonobuoys. Explosive detonations during training and testing involving the use of high-explosive munitions, including bombs, missiles, and naval gun shells, could occur in the air or at the water's surface.

Explosive detonations associated with torpedoes and explosive sonobuoys would occur in the water column; mines and demolition charges could be detonated in the water column or on the ocean bottom.

Most detonations would occur in waters greater than 200 ft. in depth, and greater than 3 NM from shore, although mine warfare, demolition, and some testing detonations would occur in shallow water close to shore.

In order to better organize and facilitate the analysis of explosives used by the Navy during training and testing that could detonate in water or at the water surface, explosive classification bins were developed. The use of explosive classification bins provides the same benefits as described for acoustic source classification bins in Section 1.4.1 (Acoustic Stressors).

Explosives detonated in water are binned by net explosive weight. The bins of explosives that are proposed for use in the Study Area are shown in Table 1-6.

Table 1-6: Explosives Analyzed

Bin	*Net Explosive Weight[1] (lb.)*	*Example Explosive Source*
E1	0.1 – 0.25	Medium-caliber projectile
E2	> 0.25 – 0.5	Medium-caliber projectile
E3	> 0.5 – 2.5	Large-caliber projectile
E4	> 2.5 – 5	Mine neutralization charge
E5	> 5 – 10	5-inch projectile
E6	> 10 – 20	Hellfire missile
E7	> 20 – 60	Demo block / shaped charge
E8	> 60 – 100	Light-weight torpedo
E9	> 100 – 250	500 lb. bomb
E10	> 250 – 500	Harpoon missile
E11	> 500 – 650	650 lb. mine
E12	> 650 – 1,000	2,000 lb. bomb
E13 [2]	>1,000 – 1,740	Mat weave

[1] Net Explosive Weight refers to the equivalent amount of TNT the actual weight of a munition may be larger due to other components.
[2] E13 is not modeled for protected species impacts in water because most energy is lost into the air or to the bottom substrate due to detonation in very shallow water. In addition, activities confined to small cove without regular marine mammal occurrence. These are not single charges, but multiple smaller charges detonated simultaneously or within a short time period.

Propagation of explosive pressure waves in water is highly dependent on environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity, which affect how the pressure waves are reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher frequency components of explosive broadband noise can propagate. Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS explains the characteristics of explosive detonations and how the above factors affect the propagation of explosive energy in the water. Because of the complexity of analyzing sound propagation in the ocean environment, the Navy relies on acoustic models in its environmental analyses that consider sound source characteristics and varying ocean conditions across the Study Area.

1.5 Proposed Action

The Navy proposes to conduct training and testing activities within the HSTT Study Area. The Navy has been conducting military readiness training and testing activities in the HSTT Study Area since the 1940s. Recently, these activities were analyzed in the 2013 Hawaii-Southern California Training and Testing EIS/OEIS (U.S. Department of the Navy, 2013). That document, and its associated MMPA authorizations, describes the training and testing activities currently conducted in the Study Area, which are similar to those proposed in this LOA request. The Study Area is virtually the same as considered in the 2013 EIS/OEIS (see Section 2.2) and issued LOAs.

1.5.1 Training Activities

The training activities that the Navy proposes to conduct in the Study Area are described in Table 1-7. The table is organized according to primary mission areas and includes the activity name, associated stressor applicable to this LOA request, description of the activity, sound source bin, the areas where the activity is conducted, and the number of activities per year and per five years. Not all sound sources are used with each activity. Under the "Annual # of Activities" column, activities show either a single number or a range of numbers to indicate the number of times that activity could occur during any single year. The "5-Year # of Activities" is the maximum an activity would occur over the 5-year period of this request. More detailed activity descriptions can be found in Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS.

The Navy's Proposed Action reflects a representative year of training to account for the natural fluctuation of training cycles and deployment schedules that generally influences the maximum level of training from occurring year after year in any 5-year period. Using a representative level of activity rather than a maximum tempo of training activity in every year has reduced the amount of hull-mounted mid-frequency active sonar estimated to be necessary to meet training requirements. Both unit-level training and major training exercises are adjusted to meet this representative year, as discussed below.

For the purposes of this LOA request, the Navy assumes that some unit-level training would be conducted using synthetic means (e.g., simulators). Additionally, the Proposed Action assumes that some unit-level active sonar training will be completed through other training exercises. By using a representative level of training activity rather than a maximum level of training activity in every year, the Proposed Action incorporates a degree of risk that the Navy will not have sufficient capacity in potential MMPA permits to conduct the necessary training to meet future national emergencies.

The Optimized Fleet Response Plan and various training plans identify the number and duration of training cycles that could occur over a five-year period. The Proposed Action considers fluctuations in training cycles and deployment schedules that do not follow a traditional annual calendar but instead are influenced by in-theater demands and other external factors. Similar to unit-level training, the Proposed Action does not analyze a maximum number of carrier strike group Composite Training Unit Exercises (one type of major exercise) every year, but instead assumes a maximum number of exercises would occur during two years of any five-year period.

Table 1-7: Proposed Training Activities Within the Study Area

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Major Training Events – Large Integrated Anti-Submarine Warfare						
Acoustic	Composite Training Unit Exercise[1]	Aircraft carrier and carrier air wing integrates with surface and submarine units in a challenging multi-threat operational environment that certifies them ready to deploy.	ASW1, ASW2, ASW3, ASW4, ASW5, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	SOCAL	2-3	12
Acoustic	Rim of the Pacific Exercise[1]	A biennial multinational training exercise in which navies from Pacific Rim nations and the United Kingdom assemble in Pearl Harbor, Hawaii, to conduct training throughout the Hawaiian Islands in a number of warfare areas. Marine mammal systems may be used during a Rim of the Pacific exercise. Components of a Rim of the Pacific exercise, such as certain mine warfare and amphibious training, may be conducted in the Southern California Range Complex.	ASW2, ASW3, ASW4, HF1, HF3, HF4, M3, MF1, MF3, MF4, MF5, MF11	HRC	0-1	2
				SOCAL	0-1	2
Major Training Events – Medium Integrated Anti-Submarine Warfare						
Acoustic	Fleet Exercise/Sustainment Exercise[1]	Aircraft carrier and carrier air wing integrates with surface and submarine units in a challenging multi-threat operational environment to maintain ability to deploy.	ASW1, ASW2, ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	HRC	1	3
				SOCAL	5	22

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Major Training Events – Medium Integrated Anti-Submarine Warfare (continued)						
Acoustic	Undersea Warfare Exercise	Elements of the anti-submarine warfare tracking exercise combine in this exercise of multiple air, surface, and subsurface units, over a period of several days. Sonobuoys are released from aircraft. Active and passive sonar used.	ASW3, ASW4, HF1, LF6, MF1, MF3, MF4, MF5, MF11, MF12	HRC	3	12
Integrated/Coordinated Training – Small Integrated Anti-Submarine Warfare Training						
Acoustic	Navy Undersea Warfare Training and Assessment Course Surface Warfare Advanced Tactical Training	Multiple ships, aircraft, and submarines integrate the use of their sensors to search for, detect, classify, localize, and track a threat submarine in order to launch an exercise torpedo.	ASW3, ASW4, HF1, MF1, MF3, MF4, MF5	HRC	1	2
				SOCAL	2-3	12
Integrated/Coordinated Training – Medium Coordinated Anti-Submarine Warfare Training						
Acoustic	Submarine Commanders Course	Train prospective submarine Commanding Officers to operate against surface, air, and subsurface threats.	ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, TORP1, TORP2	HRC	2	10
				SOCAL	2	2

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Integrated/Coordinated Training – Small Coordinated Anti-Submarine Warfare Training						
Acoustic	Amphibious Ready Group/Marine Expeditionary Unit Exercise Group Sail Independent Deployer Certification Exercise/Tailored Anti-Submarine Warfare Training	Small-scale, short duration, coordinated anti-submarine warfare exercises	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	HRC	2	10
				SOCAL	10-14	58
Amphibious Warfare						
Explosive	Naval Surface Fire Support Exercise – at Sea	Surface ship uses large-caliber gun to support forces ashore; however, land target simulated at sea. Rounds impact water and are scored by passive acoustic hydrophones located at or near target area.	Large-caliber HE rounds (E5)	HRC (W188)	15	75
Acoustic	Amphibious Marine Expeditionary Unit Exercise	Navy and Marine Corps forces conduct advanced integration training in preparation for deployment certification.	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	SOCAL	2-3	12
Acoustic	Amphibious Marine Expeditionary Unit Integration Exercise	Navy and Marine Corps forces conduct integration training at sea in preparation for deployment certification.	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	SOCAL	2-3	12

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Amphibious Warfare (continued)						
Acoustic	Marine Expeditionary Unit Composite Training Unit Exercise	Amphibious Ready Group exercises are conducted to validate the Marine Expeditionary Unit's readiness for deployment and includes small boat raids; visit, board, search, and seizure training; helicopter and mechanized amphibious raids; and a non-combatant evacuation operation.	ASW2, ASW3, ASW4, HF1, MF1, MF3, MF4, MF5, MF11	SOCAL	2-3	12
Anti-Submarine Warfare						
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Helicopter	Helicopter crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF4, MF5, TORP1	HRC	6	30
				SOCAL	104	520
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft crews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF5, TORP1	HRC	10	50
				SOCAL	25	125
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Ship	Surface ship crews search for, track, and detect submarines. Exercise torpedoes are used during this event.	ASW3, MF1, TORP1	HRC	50	250
				SOCAL	117	585
Acoustic	Anti-Submarine Warfare Torpedo Exercise – Submarine	Submarine crews search for, track, and detect submarines. Exercise torpedoes are used during this event.	ASW4, HF1, MF3, TORP2	HRC	48	240
				SOCAL	13	65

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Anti-Submarine Warfare (continued)						
Acoustic	Anti-Submarine Warfare Tracking Exercise – Helicopter	Helicopter crews search for, track, and detect submarines.	MF4, MF5	HRC	159	795
				SOCAL, PMSR	524	2,620
				HSTT Transit Corridor	6	30
Acoustic	Anti-Submarine Warfare Tracking Exercise – Maritime Patrol Aircraft	Maritime patrol aircraft aircrews search for, track, and detect submarines. Recoverable air launched torpedoes are employed against submarine targets.	MF5	HRC	32	160
				SOCAL, PMSR	56	280
Acoustic	Anti-Submarine Warfare Tracking Exercise – Ship	Surface ship crews search for, track, and detect submarines.	ASW3, MF1, MF11, MF12	HRC	224	1,120
				SOCAL, PMSR	423	2,115
Acoustic	Anti-Submarine Warfare Tracking Exercise – Submarine	Submarine crews search for, track, and detect submarines.	ASW4, HF1, HF3, MF3	HRC	200	1,000
				SOCAL, PMSR	50	250
				HSTT Transit Corridor	7	35
Explosive, Acoustic	Service Weapons Test	Air, surface, or submarine crews employ explosive torpedoes against virtual targets.	HF1, MF3, MF6, TORP2, Explosive torpedoes (E11)	HRC	2	10
				SOCAL	1	5

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Mine Warfare						
Acoustic	Airborne Mine Countermeasure – Mine Detection	Helicopter aircrews detect mines using towed or laser mine detection systems.	HF4	SOCAL	10	50
Explosive, Acoustic	Civilian Port Defense – Homeland Security Anti-Terrorism/Force Protection Exercises	Maritime security personnel train to protect civilian ports against enemy efforts to interfere with access to those ports.	HF4, SAS2 E2, E4	Pearl Harbor, HI	1	5
				San Diego, CA	1-3	12
Explosive	Marine Mammal Systems	The Navy deploys trained bottlenose dolphins (*Tursiops truncatus*) and California sea lions (*Zalophus californianus*) as part of the marine mammal mine-hunting and object-recovery system.	E7	HRC	10	50
				SOCAL	175	875
Acoustic	Mine Countermeasure Exercise – Ship Sonar	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.	HF4, HF8, MF1K	HRC	30	150
				SOCAL	92	460
Acoustic	Mine Countermeasure Exercise - Surface	Mine countermeasure ship crews detect, locate, identify, and avoid mines while navigating restricted areas or channels, such as while entering or leaving port.	HF4	SOCAL	266	1,330
Explosive, Acoustic	Mine Countermeasures Mine Neutralization Remotely Operated Vehicle	Ship, small boat, and helicopter crews locate and disable mines using remotely operated underwater vehicles.	HF4, E4	HRC	6	30
				SOCAL	372	1,860

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Mine Warfare (continued)						
Explosive	Mine Neutralization Explosive Ordnance Disposal	Personnel disable threat mines using explosive charges.	E4, E5, E6, E7	HRC (Puuloa)	20	100
				SOCAL (IB, TAR 2, TAR 3, TAR 21, SWAT 3, SOAR)	194	970
Acoustic	Submarine Mine Exercise	Submarine crews practice detecting mines in a designated area.	HF1	HRC	40	200
				SOCAL	12	60
Acoustic	Surface Ship Object Detection	Ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.	MF1K, HF8	HRC	42	210
				SOCAL	164	820
Explosive	Underwater Demolitions Multiple Charge – Mat Weave and Obstacle Loading	Military personnel use explosive charges to destroy barriers or obstacles to amphibious vehicle access to beach areas.	E10, E13	SOCAL (TAR 2, TAR 3)	18	90
Explosive	Underwater Demolition Qualification and Certification	Navy divers conduct various levels of training and certification in placing underwater demolition charges.	E6, E7	HRC (Puuloa)	25	125
				SOCAL (TAR 2)	120	600

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Surface Warfare						
Explosive	Bombing Exercise Air-to-Surface	Fixed-wing aircrews deliver bombs against surface targets.	E12[2]	HRC	187	935
				SOCAL	640	3,200
				HSTT Transit Corridor	5	25
Explosive	Gunnery Exercise Surface-to-Surface Boat Medium-Caliber	Small boat crews fire medium-caliber guns at surface targets.	E1, E2	HRC	10	50
				SOCAL	14	70
Explosive	Gunnery Exercise Surface-to-Surface Ship Large-caliber	Surface ship crews fire large-caliber guns at surface targets.	E5	HRC	32	160
				SOCAL	200	1,000
				HSTT Transit Corridor	13	65
Explosive	Gunnery Exercise Surface-to-Surface Ship Medium-Caliber	Surface ship crews fire medium-caliber guns at surface targets.	E1, E2	HRC	50	250
				SOCAL	180	900
				HSTT Transit Corridor	40	200
Explosive, Acoustic	Independent Deployer Certification Exercise/Tailored Surface Warfare Training	Multiple ships, aircraft and submarines conduct integrated multi-warfare training with a surface warfare emphasis. Serves as a ready-to-deploy certification for individual surface ships tasked with surface warfare missions.	E1, E3, E6, E10	SOCAL	1	5

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Surface Warfare (continued)						
Explosive	Integrated Live Fire Exercise	Naval Forces defend against a swarm of surface threats (ships or small boats) with bombs, missiles, rockets, and small-, medium- and large-caliber guns.	E1, E3, E6, E10	HRC (W188A)	1	5
				SOCAL (SOAR)	1	5
Explosive	Missile Exercise Air-to-Surface	Fixed-wing and helicopter aircrews fire air-to-surface missiles at surface targets.	E6, E8, E10	HRC	10	50
				SOCAL	210	1,050
Explosive	Missile Exercise Air-to-Surface Rocket	Helicopter aircrews fire both precision-guided and unguided rockets at surface targets.	E3	HRC	227	1,135
				SOCAL	246	1,230
Explosive	Missile Exercise Surface-to-Surface	Surface ship crews defend against surface threats (ships or small boats) and engage them with missiles.	E6, E10	HRC (W188)	20	100
				SOCAL (W291)	10	50
Explosive, Acoustic	Sinking Exercise	Aircraft, ship, and submarine crews deliberately sink a seaborne target, usually a decommissioned ship made environmentally safe for sinking according to U.S. Environmental Protection Agency standards, with a variety of munitions.	TORP2, E5, E10, E12	HRC	1–3	7
				SOCAL	0–1	1
Pile driving	Elevated Causeway System	A pier is constructed off of the beach. Piles are driven into the bottom with an impact hammer. Piles are removed from seabed via vibratory extractor. Only in-water impacts are analyzed.	Impact hammer or vibratory extractor	SOCAL	2	10

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Other Training Exercises (continued)						
Acoustic	Kilo Dip	Functional check of the dipping sonar prior to conducting a full test or training event on the dipping sonar.	MF4	HRC	60	300
				SOCAL	2,400	12,000
Acoustic	Submarine Navigation Exercise	Submarine crews operate sonar for navigation and object detection while transiting into and out of port during reduced visibility.	HF1, MF3	Pearl Harbor, HI	220	1,100
				San Diego Bay, CA	80	400
Acoustic	Submarine Sonar Maintenance and Systems Checks	Maintenance of submarine sonar systems is conducted pierside or at sea.	MF3	HRC	260	1,300
				Pearl Harbor, HI	260	1,300
				SOCAL	93	465
				San Diego Bay, CA	92	460
				HSTT Transit Corridor	10	50
Acoustic	Submarine Under Ice Certification	Submarine crews train to operate under ice. Ice conditions are simulated during training and certification events.	HF1	HRC	12	60
				SOCAL	6	30

Table 1-7: Proposed Training Activities Within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Other Training Exercises (continued)						
Acoustic	Surface Ship Sonar Maintenance and Systems Checks	Maintenance of surface ship sonar systems is conducted pierside or at sea.	HF8, MF1	HRC	75	375
				Pearl Harbor, HI	80	400
				SOCAL	250	1,250
				San Diego, CA	250	1,250
				HSTT Transit Corridor	8	40
Acoustic	Unmanned Underwater Vehicle Training – Certification and Development	Unmanned underwater vehicle certification involves training with unmanned platforms to ensure submarine crew proficiency. Tactical development involves training with various payloads for multiple purposes to ensure that the systems can be employed effectively in an operational environment.	FLS2, M3, SAS2	HRC	25	125
				SOCAL	10	50

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, PMRF = Pacific Missile Range Facility, BARSTUR = Barking Sands Tactical Underwater Range, BSURE = Barking Sands Underwater Range Expansion, PMSR = Point Mugu Sea Range Overlap, TAR = Training Area and Range, SOAR = Southern California Anti-Submarine Warfare Range, IB = Imperial Beach Minefield
1. Any non-antisubmarine warfare activity that could occur is captured in the individual activities.
2. For the Bombing Exercise Air-to-Surface, all activities were analyzed using E12 explosive bin, but smaller explosives are frequently used.

1.5.2 Testing Activities

The testing activities that the Navy proposes to conduct in the Study Area are described in Tables 1-8 through 1-11. The table includes the activity name, associated stressor(s), description of the activity, sound source bin, the areas where the activity is conducted, and the number of activities per year and per five years. Not all sound sources are used with each activity. Under the "Annual # of Activities" column, activities show either a single number or a range of numbers to indicate the number of times that activity could occur during any single year. The "5-Year # of Activities" is the maximum times an activity would occur over the 5-year period of this request. More detailed activity descriptions can be found in the HSTT Draft EIS/OEIS.

1.5.2.1 Naval Air Systems Command

Table 1-8: Naval Air Systems Command Proposed Testing Activities Within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Anti-Submarine Warfare						
Acoustic	Anti-Submarine Warfare Torpedo Test	This event is similar to the training event torpedo exercise. Test evaluates anti-submarine warfare systems onboard rotary-wing and fixed-wing aircraft and the ability to search for, detect, classify, localize, track, and attack a submarine or similar target.	MF5, TORP1	HRC	17-22	95
				SOCAL	35-71	247
Explosive, Acoustic	Anti-Submarine Warfare Tracking Test – Helicopter	This event is similar to the training event anti-submarine tracking exercise – helicopter. The test evaluates the sensors and systems used to detect and track submarines and to ensure that helicopter systems used to deploy the tracking systems perform to specifications.	MF4, MF5, E3	SOCAL	30-132	252
Explosive, Acoustic	Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft	The test evaluates the sensors and systems used by maritime patrol aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.	ASW2, ASW5, MF5, MF6, E1, E3	HRC	54-61	284
				SOCAL	58-68	310

Table 1-8: Naval Air Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Anti-Submarine Warfare (continued)						
Explosive, Acoustic	Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a lot or group of sonobuoys in advance of delivery to the fleet for operational use.	ASW2, ASW5, HF5, HF6, LF4, MF5, MF6, E1, E3, E4	SOCAL	160	800
Mine Warfare						
Acoustic	Airborne Dipping Sonar Minehunting Test	A mine-hunting dipping sonar system that is deployed from a helicopter and uses high-frequency sonar for the detection and classification of bottom and moored mines.	HF4	SOCAL	0-12	12
Explosive	Airborne Mine Neutralization System Test	A test of the airborne mine neutralization system that evaluates the system's ability to detect and destroy mines from an airborne mine countermeasures capable helicopter (e.g., MH-60). The airborne mine neutralization system uses up to four unmanned underwater vehicles equipped with high-frequency sonar, video cameras, and explosive and non-explosive neutralizers.	E4	SOCAL	11-31	75
Acoustic	Airborne Sonobuoy Minehunting Test	A mine-hunting system made up of sonobuoys deployed from a helicopter. A field of sonobuoys, using high-frequency sonar, is used for detection and classification of bottom and moored mines.	HF6	SOCAL	3-9	21

Table 1-8: Naval Air Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Surface Warfare						
Explosive	Air-to-Surface Bombing Test	This event is similar to the training event bombing exercise air-to-surface. Fixed-wing aircraft test the delivery of bombs against surface maritime targets with the goal of evaluating the bomb, the bomb carry and delivery system, and any associated systems that may have been newly developed or enhanced.	E9	HRC	8	40
				SOCAL	14	70
Explosive	Air-to-Surface Gunnery Test	This event is similar to the training event gunnery exercise air-to-surface. Fixed-wing and rotary-wing aircrews evaluate new or enhanced aircraft guns against surface maritime targets to test that the gun, gun ammunition, or associated systems meet required specifications or to train aircrew in the operation of a new or enhanced weapons system.	E1	HRC	5	25
				SOCAL	30-60	240
Explosive	Air-to-Surface Missile Test	This event is similar to the training event missile exercise air-to-surface. Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapons system or as part of another systems integration test.	E6, E9, E10	HRC	18	90
				SOCAL	48-60	276

Table 1-8: Naval Air Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Surface Warfare (continued)						
Explosive	Rocket Test	Rocket tests are conducted to evaluate the integration, accuracy, performance, and safe separation of guided and unguided 2.75-inch rockets fired from a hovering or forward flying helicopter or tilt rotor aircraft.	E3	HRC	2	10
				SOCAL	18-22	102
Other Testing Activities						
Acoustic	Kilo Dip	Functional check of a helicopter deployed dipping sonar system (e.g., AN/AQS-22) prior to conducting a testing or training event using the dipping sonar system.	MF4	SOCAL	0-6	6
Acoustic	Undersea Range System Test	Post installation node survey and test and periodic testing of range Node transmit functionality.	MF9	HRC	11-28	90

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex

1.5.2.2 Naval Sea Systems Command

Table 1-9: Naval Sea Systems Command Proposed Testing Activities Within the Study Area

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Anti-Submarine Warfare						
Acoustic	Anti-Submarine Warfare Mission Package Testing	Ships and their supporting platforms (e.g., rotary-wing aircraft and unmanned aerial systems) detect, localize, and prosecute submarines.	ASW1, ASW2, ASW3, ASW5, MF1, MF4, MF5, MF12, TORP1	HRC	22	110
				SOCAL	23	115
Acoustic	At-Sea Sonar Testing	At-sea testing to ensure systems are fully functional in an open ocean environment.	ASW3, ASW4, HF1, LF4, LF5, M3, MF1, MF1K, MF2, MF3, MF5, MF9, MF10, MF11	HRC	16	78
				HRC - SOCAL	1	5
				SOCAL	20	99
Acoustic	Countermeasure Testing	Countermeasure testing involves the testing of systems that will detect, localize, and track incoming weapons, including marine vessel targets. Testing includes surface ship torpedo defense systems and marine vessel stopping payloads.	ASW3, ASW4, HF5, TORP1, TORP2	HRC	8	40
				HRC - SOCAL	4	20
				SOCAL	11	55
				HSTT Transit Corridor	2	10
Acoustic	Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities.	HF1, HF3, HF8, M3, MF1, MF3, MF9	Pearl Harbor, HI	7	35
				San Diego, CA	7	35

Table 1-9: Naval Sea Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Anti-Submarine Warfare (continued)						
Acoustic	Submarine Sonar Testing/Maintenance	Pierside and at-sea testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.	HF1, HF3, M3, MF3	HRC	4	20
				Pearl Harbor, HI	17	85
				San Diego, CA	24	120
Acoustic	Surface Ship Sonar Testing/Maintenance	Pierside and at-sea testing of ship systems occurs periodically following major maintenance periods and for routine maintenance.	ASW3, MF1, MF1K, MF9, MF10	HRC	3	15
				Pearl Harbor, HI	3	15
				San Diego, CA	3	15
				SOCAL	3	15
Explosive, Acoustic	Torpedo (Explosive) Testing	Air, surface, or submarine crews employ explosive and non-explosive torpedoes against artificial targets.	ASW3, HF1, HF5, HF6, MF1, MF3, MF4, MF5, MF6, TORP1, TORP2, E8, E11	HRC (W188)	8	40
				HRC (W188) SOCAL	3	15
				SOCAL	8	40
Acoustic	Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels.	ASW3, ASW4, HF1, HF6, M3, MF1, MF3, MF4, MF5, MF6, TORP1, TORP2	HRC	8	40
				HRC SOCAL	9	45
				SOCAL	8	40

Table 1-9: Naval Sea Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	***Activity Name***	***Description***	***Source Bin***	***Location***	***Annual # of Activities***	***5-Year # of Activities***
Mine Warfare						
Explosive, Acoustic	Mine Countermeasure and Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.	HF4, E4	SOCAL	11	55
Explosive, Acoustic	Mine Countermeasure Mission Package Testing	Vessels and associated aircraft conduct mine countermeasure operations.	HF4, SAS2, E4	HRC	19	80
				SOCAL	58	290
Acoustic	Mine Detection and Classification Testing	Air, surface, and subsurface vessels detect and classify mines and mine-like objects. Vessels also assess their potential susceptibility to mines and mine-like objects.	HF1, HF8, MF1, MF5	HRC	2	10
				HRC SOCAL	2	6
				SOCAL	11	55
Surface Warfare						
Explosive	Gun Testing – Large-Caliber	Surface crews defend against surface targets with large-caliber guns.	E3	HRC	7	35
				HRC - SOCAL	72	360
				SOCAL	7	35
Explosive	Gun Testing – Medium-Caliber	Surface crews defend against surface targets with medium-caliber guns.	E1	HRC	4	20
				HRC - SOCAL	48	240
				SOCAL	4	20
Explosive	Missile and Rocket Testing	Missile and rocket testing includes various missiles or rockets fired from submarines and surface combatants. Testing of the launching system and ship defense is performed.	E6	HRC	13	65
				HRC - SOCAL	24	120
				SOCAL	20	100

Table 1-9: Naval Sea Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	***Activity Name***	***Description***	***Source Bin***	***Location***	***Annual # of Activities***	***5-Year # of Activities***
Unmanned Systems						
Acoustic	Unmanned Surface Vehicle System Testing	Testing involves the production or upgrade of unmanned surface vehicles. This may include tests of mine detection capabilities, evaluations of the basic functions of individual platforms, or complex events with multiple vehicles.	HF4, SAS2	HRC	3	15
				SOCAL	4	20
Acoustic	Unmanned Underwater Vehicle Testing	Testing involves the production or upgrade of unmanned underwater vehicles. This may include tests of mine detection capabilities, evaluations of the basic functions of individual platforms, or complex events with multiple vehicles.	HF4, MF9	HRC	3	15
				SOCAL	291	1,455
Vessel Evaluation						
Acoustic	Submarine Sea Trials – Weapons System Testing	Submarine weapons and sonar systems are tested at-sea to meet the integrated combat system certification requirements.	HF1, M3, MF3, MF9, MF10, TORP2	HRC	1	5
				SOCAL	1	5
Explosive	Surface Warfare Testing	Tests the capabilities of shipboard sensors to detect, track, and engage surface targets. Testing may include ships defending against surface targets using explosive and non-explosive rounds, gun system structural test firing, and demonstration of the response to Call for Fire against land-based targets (simulated by sea-based locations).	E1, E5, E8	HRC	9	45
				HRC - SOCAL	63	313
				SOCAL	14-16	72

Table 1-9: Naval Sea Systems Command Proposed Testing Activities within the Study Area (continued)

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Vessel Evaluation (continued)						
Acoustic	Undersea Warfare Testing	Ships demonstrate capability of countermeasure systems and underwater surveillance, weapons engagement, and communications systems. This tests ships ability to detect, track, and engage undersea targets.	ASW4, HF4, HF8, MF1, MF4, MF5, MF6, TORP1, TORP2	HRC	7	35
				HRC SOCAL	12-16	32
				SOCAL	11	51
Acoustic	Vessel Signature Evaluation	Surface ship, submarine and auxiliary system signature assessments. This may include electronic, radar, acoustic, infrared and magnetic signatures.	ASW3	HRC	4	20
				HRC SOCAL	36	180
				SOCAL	24	120
Other Testing Activities						
Acoustic	Insertion/Extraction	Testing of submersibles capable of inserting and extracting personnel and payloads into denied areas from strategic distances.	M3, MF9	HRC	1	5
				SOCAL	1	5
Acoustic	Signature Analysis Operations	Surface ship and submarine testing of electromagnetic, acoustic, optical, and radar signature measurements.	HF1, M3, MF9	HRC	2	10
				SOCAL	1	5

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, CA = California, HI = Hawaii

1.5.2.3 Office of Naval Research

Table 1-10: Office of Naval Research Proposed Testing Activities Within the Study Area

Stressor Category	*Activity Name*	*Description*	*Source Bin*	*Location*	*Annual # of Activities*	*5-Year # of Activities*
Acoustic and Oceanographic Science and Technology						
Explosive, Acoustic	Acoustic and Oceanographic Research	Research using active transmissions from sources deployed from ships and unmanned underwater vehicles. Research sources can be used as proxies for current and future Navy systems.	AG, ASW2, BB4, BB9, LF3, LF4, LF5, MF8, MF9, MF9, MF9, E3	HRC	2	10
				SOCAL	4	20
Acoustic	Long Range Acoustic Communications	Bottom mounted acoustic source off of the Hawaiian Island of Kauai will transmit a variety of acoustic communications sequences.	LF4	HRC	3	15

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex

1.5.2.4 Space and Naval Warfare Systems Command

Table 1-11: Space and Naval Warfare Systems Command Proposed Testing Activities Within the Study Area

Stressor Category	Activity Name	Description	Source Bin	Location	Annual # of Activities	5-Year # of Activities
Acoustic	Anti-Terrorism/Force Protection	Testing sensor systems that can detect threats to naval piers, ships, and shore infrastructure.	SD1	San Diego, CA	14	70
				SOCAL	16	80
Acoustic	Communications	Testing of underwater communications and networks to extend the principles of FORCEnet below the ocean surface.	ASW2, ASW5, HF6, LF4	HRC	0-1	3
				SOCAL	10	50
Acoustic	Energy and Intelligence, Surveillance, and Reconnaissance Sensor Systems	Develop, integrate, and demonstrate Intelligence, Surveillance, and Reconnaissance systems and in-situ energy systems to support deployed systems.	AG, HF2, HF7, LF4, LF5, LF6, MF10	HRC	11-15	61
				SOCAL	49-55	253
				HSTT Transit Corridor	8	40
Acoustic	Vehicle Testing	Testing of surface and subsurface vehicles and sensor systems, which may involve Unmanned Underwater Vehicles, gliders, and Unmanned Surface Vehicles.	BB4, FLS2, FLS3, HF6, LF3, M3, MF9, MF13, SAS1, SAS2, SAS3	HRC	4	20
				SOCAL	166	830
				HSTT Transit Corridor	2	10

Notes: HRC = Hawaii Range Complex, SOCAL = Southern California Range Complex, HSTT = Hawaii-Southern California Training and Testing, CA = California

1.5.3 SUMMARY OF ACOUSTIC AND EXPLOSIVE SOURCES ANALYZED FOR TRAINING AND TESTING

Tables 1-12 through 1-15 show the acoustic source classes and numbers, air gun sources, pile driving and removal activities, and explosive source bins and numbers associated with Navy training and testing in the Study Area that were analyzed in this LOA request.

Table 1-12: Acoustic Source Classes Analyzed and Numbers Used during Training and Testing Activities

Source Class Category	*Bin*	*Description*	*Unit*[1]	*Training*		*Testing*	
				Annual[2]	*5-year Total*	*Annual*[2]	*5-year Total*
Low-Frequency (LF): Sources that produce signals less than 1 kHz	LF3	LF sources greater than 200 dB	H	0	0	195	975
	LF4	LF sources equal to 180 dB and up to 200 dB	H	0	0	589 – 777	3,131
			C	0	0	20	100
	LF5	LF sources less than 180 dB	H	0	0	1,814 – 2,694	9,950
	LF6	LF sources greater than 200 dB with long pulse lengths	H	121 – 167	668	40–80	240
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-61)	H	5,779 – 6,702	28,809	1,540	5,612
	MF1K	Kingfisher mode associated with MF1 sonars	H	100	500	14	70
	MF2[3]	Hull-mounted surface ship sonars (e.g., AN/SQS-56)	H	0	0	54	270
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	2,080 – 2,175	10,440	1,311	6,553
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)	H	414 – 489	2,070	311 – 475	1,717
	MF5	Active acoustic sonobuoys (e.g., DICASS)	C	5,704 – 6,124	28,300	5,250 – 5,863	27,120

Table 1-12: Acoustic Source Classes Analyzed and Numbers Used during Training and Testing Activities (continued)

Source Class Category	*Bin*	*Description*	*Unit*[1]	*Training*		*Testing*	
				Annual[2]	*5-year Total*	*Annual*[2]	*5-year Total*
Mid-Frequency (MF): Tactical and non-tactical sources that produce signals between 1 and 10 kHz	MF6	Active underwater sound signal devices (e.g., MK 84)	C	9	45	1,141 – 1,226	5,835
	MF8	Active sources (greater than 200 dB) not otherwise binned	H	0	0	70	350
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	5,139 – 5,165	25,753
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	1,824– 1,992	9,288
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%	H	718 – 890	3,597	56	280
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%	H	161 – 215	884	660	3,300
	MF13	MF sonar source	H	0	0	300	1,500
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 and 100 kHz	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)	H	1,795 – 1,816	8,939	772	3,859
	HF2	HF Marine Mammal Monitoring System	H	0	0	120	600
	HF3	Other hull-mounted submarine sonars (classified)	H	287	1,345	110	549

Table 1-12: Acoustic Source Classes Analyzed and Numbers Used during Training and Testing Activities (continued)

Source Class Category	*Bin*	*Description*	*Unit*[1]	*Training*		*Testing*	
				Annual[2]	*5-year Total*	*Annual*[2]	*5-year Total*
High-Frequency (HF): Tactical and non-tactical sources that produce signals between 10 and 100 kHz	HF4	Mine detection, classification, and neutralization sonar (e.g., AN/SQS-20)	H	2,316	10,380	16,299 – 16,323	81,447
	HF5	Active sources (greater than 200 dB) not otherwise binned	H	0	0	960	4,800
			C	0	0	40	200
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned	H	0	0	1,000 – 1,009	5,007
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned	H	0	0	1,380	6,900
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)	H	118	588	1,032	3,072
Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic countermeasures systems) used during ASW training and testing activities	ASW1	MF systems operating above 200 dB	H	194 – 261	1,048	470	2,350
	ASW2	MF Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)	C	688–790	3,346	4,334 – 5,191	23,375
	ASW3	MF towed active acoustic countermeasure systems (e.g., AN/SLQ-25)	H	5,005 – 6,425	25,955	2,741	13,705

Table 1-12: Acoustic Source Classes Analyzed and Numbers Used during Training and Testing Activities (continued)

Source Class Category	*Bin*	*Description*	*Unit[1]*	*Training*		*Testing*	
				Annual[2]	*5-year Total*	*Annual[2]*	*5-year Total*
Anti-Submarine Warfare (ASW): Tactical sources (e.g., active sonobuoys and acoustic countermeasures systems) used during ASW training and testing activities	ASW4	MF expendable active acoustic device countermeasures (e.g., MK 3)	C	1,284 – 1,332	6,407	2,244	10,910
	ASW5[4]	MF sonobuoys with high duty cycles	H	220– 300	1,260	522–592	2,740
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes	TORP1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)	C	231–237	1,137	923 – 971	4,560
	TORP2	Heavyweight torpedo (e.g., MK 48)	C	521 – 587	2,407	404	1,948
	TORP3		C	0	0	45	225
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars used for ship navigation and safety	FLS2	HF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	28	140	448 – 544	2,432
	FLS3	VHF sources with short pulse lengths, narrow beam widths, and focused beam patterns	H	0	0	2,640	13,200
Acoustic Modems (M): Systems used to transmit data through the water	M3	MF acoustic modems (greater than 190 dB)	H	61	153	518	2,588
Swimmer Detection Sonars (SD): Systems used to detect divers and submerged swimmers	SD1–SD2	HF and VHF sources with short pulse lengths, used for the detection of swimmers and other objects for the purpose of port security	H	0	0	10	50

Table 1-12: Acoustic Source Classes Analyzed and Numbers Used during Training and Testing Activities (continued)

Source Class Category	Bin	Description	Unit[1]	Training		Testing	
				Annual[2]	5-year Total	Annual[2]	5-year Total
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS1	MF SAS systems	H	0	0	1,960	9,800
	SAS2	HF SAS systems	H	900	4,498	8,584	42,920
	SAS3	VHF SAS systems	H	0	0	4,600	23,000
	SAS4	MF to HF broadband mine countermeasure sonar	H	42	210	0	0
Broadband Sound Sources (BB): Sonar systems with large frequency spectra, used for various purposes	BB4	LF to MF oceanographic source	H	0	0	810 – 1,170	4,434
	BB7	LF oceanographic source	C	0	0	28	140
	BB9	MF optoacoustic source	H	0	0	480	2,400

[1] H = hours; C = count (e.g., number of individual pings or individual sonobuoys).
[2] Expected annual use may vary per bin because the number of events may vary from year to year, as described in Section 1.5 (Proposed Action).
[3] MF2/MF2K are sources on frigate class ships, which were decommissioned during Phase II.
[4] Formerly ASW2 (H) in Phase II.
Notes: dB = decibel(s), kHz = kilohertz

Table 1-13: Training and Testing Air Gun Sources Quantitatively Analyzed in the Study Area

Source Class Category	Bin	Unit[1]	Training		Testing	
			Annual	5-year Total	Annual	5-year Total
Air Guns (AG): small underwater air guns	AG	C	0	0	284	1,420

1 C = count. One count (C) of AG is equivalent to 100 air gun firings.

Table 1-14: Summary of Pile Driving and Removal Activities per 24-Hour Period

Method	Piles Per 24-Hour Period	Time Per Pile	Total Estimated Time of Noise Per 24-Hour Period
Pile Driving (Impact)	6	15 minutes	90 minutes
Pile Removal (Vibratory)	12	6 minutes	72 minutes

Table 1-15: Explosive Source Bins Analyzed and Numbers Used during Training and Testing Activities

Bin	*Net Explosive Weight (lb.)*	*Example Explosive Source*	*Modeled Underwater Detonation Depths (ft.)*[1]	*Training*		*Testing*	
				Annual	*5-year Total*	*Annual*	*5-year Total*
E1	0.1–0.25	Medium-caliber projectiles	0.3, 60	2,940	14,700	8,916 – 15,216	62,880
E2	> 0.25–0.5	Medium-caliber projectiles	0.3, 50	1,746	8,730	0	0
E3	> 0.5–2.5	Large-caliber projectiles	0.3, 60	2,797	13,985	2,880 – 3,124	14,844
E4	> 2.5–5	Mine neutralization charge	10, 16, 33, 50, 61, 65, 650	38	190	634 – 674	3,065
E5	> 5–10	5 in. projectiles	0.3, 10, 50	4,730 – 4,830	23,750	1,400	7,000
E6	> 10–20	Hellfire missile	0.3, 10, 50, 60	592	2,872	26 – 38	166
E7	> 20–60	Demo block/ shaped charge	10, 50, 60	13	65	0	0
E8	> 60–100	Lightweight torpedo	0.3, 150	33 – 88	170	57	285
E9	> 100–250	500 lb. bomb	0.3	410 – 450	2,090	4	20
E10	> 250–500	Harpoon missile	0.3	219 – 224	1,100	30	150
E11	> 500–650	650 lb. mine	61, 150	7 – 17	45	12	60
E12	> 650–1,000	2,000 lb. bomb	0.3	16 – 21	77	0	0
E13	> 1,000–1,740	Multiple Mat Weave charges	NA[3]	9	45	0	0

[1] Net Explosive Weight refers to the amount of explosives; the actual weight of a munition may be larger due to other components.
[2] HBX refers to the high blast explosive family of binary explosives composed of royal demolition explosive (explosive nitroamine), trinitrotoluene (TNT), powdered aluminum, and D-2 wax with calcium chloride.
[3] Not modeled because charge is detonated in surf zone; not a single E13 charge, but multiple smaller charges detonated in quick succession
Notes: in. = inch(es), lb. = pound(s), ft. = feet

1.5.4 Vessel Movements

Vessels movements include both surface and sub-surface operations. Vessels used as part of the Proposed Action include ships, submarines, unmanned vessels, and boats ranging in size from small, 22 ft. rigid hull inflatable boats to aircraft carriers with lengths up to 1,092 ft.

Large Navy ships greater than 60 ft. generally operate at speeds in the range of 10 to 15 knots for fuel conservation. Submarines generally operate at speeds in the range of 8 to 13 knots in transits and less than those speeds for certain tactical maneuvers. Small craft (for purposes of this discussion – less than 60 ft. in length) have much more variable speeds (dependent on the mission). While these speeds are representative of most events, some vessels need to temporarily operate outside of these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier engaged in flight operations must adjust its speed through the water accordingly. Conversely, there are other instances such as launch and recovery of a small rigid hull inflatable boat, vessel boarding, search, and seizure training events or retrieval of a target when vessels will be dead in the water or moving slowly ahead to maintain steerage. Additionally, there are specific events including high speed tests of newly constructed vessels. The Navy anticipates testing large unmanned surface vessels, some of which will be at high speed.

The number of Navy vessels used in the Study Area varies based on military training and testing requirements, deployment schedules, annual budgets, and other unpredictable factors. Most training and testing activities involve the use of vessels. These activities could be widely dispersed throughout the Study Area, but would be typically conducted near naval ports, piers, and range areas. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours up to 2 weeks. Navy vessel traffic would especially be concentrated near San Diego, California and Pearl Harbor, Hawaii. There is no seasonal differentiation in Navy vessel use. Large vessel movement primarily occurs with the majority of the traffic flowing between the installations and the OPAREAS. Support craft would be more concentrated in the coastal waters in the areas of naval installations, ports and ranges.

The number of activities that include the use of vessels for testing events is lower (around 18 percent) than the number of training activities. In addition, testing often occurs jointly with a training event so it is likely that the testing activity would be conducted from a training vessel. Vessel movement in conjunction with testing activities could occur throughout the Study Area, but would be typically conducted near naval ports, piers, range complexes.

Additionally, a variety of smaller craft will be operated within the Study Area. Small craft types, sizes and speeds vary. During training and testing, speeds generally range from 10 to 14 knots; however, vessels can and will, on occasion, operate within the entire spectrum of their specific operational capabilities. In all cases, the vessels/craft will be operated in a safe manner consistent with the local conditions.

Example Navy boats and vessels (*from top to bottom, then left to right*): Combat Rubber Raider Craft, 21-ft Rigid Hulled Inflatable Boat, Littoral Combat Ship, Zumwalt class destroyer, Arleigh Burke class destroyer, Nimitz class aircraft carrier

1.5.5 STANDARD OPERATING PROCEDURES

For training and testing to be effective, units must be able to safely use their sensors and weapon systems as they are intended to be used in a real-word situation and to their optimum capabilities. While standard operating procedures are designed for the safety of personnel and equipment and to ensure the success of training and testing activities, their implementation often yields additional benefits on environmental, socioeconomic, public health and safety, and cultural resources.

Navy standard operating procedures have been developed and refined over years of experience and are broadcast via numerous naval instructions and manuals, including, but not limited to:

- Ship, submarine, and aircraft safety manuals
- Ship, submarine, and aircraft standard operating manuals
- Fleet Area Control and Surveillance Facility range operating instructions
- Fleet exercise publications and instructions
- Naval Sea Systems Command test range safety and standard operating instructions
- Navy instrumented range operating procedures
- Naval shipyard sea trial agendas
- Research, development, test, and evaluation plans
- Naval gunfire safety instructions
- Navy planned maintenance system instructions and requirements
- Federal Aviation Administration regulations
- International Regulations for Preventing Collisions at Sea

Because standard operating procedures are essential to safety and mission success, the Navy considers them to be part of the proposed activities under the Proposed Action, and has included them in the environmental analysis. Standard operating procedures that are recognized as providing a potential benefit on marine mammals during training and testing activities are noted below and discussed in more detail within the HSTT Draft EIS/OEIS.

- Vessel safety
- Weapons Firing Safety
- Target Deployment Safety
- Towed In-Water Device Safety
- Pile Driving Safety

Standard operating procedures (which are implemented regardless of their secondary benefits) are different from mitigation measures (which are designed entirely for the purpose of avoiding or reducing potential impacts of the Proposed Action). Information on mitigation measures is provided in Chapter 11 (Mitigation Measures) and is summarized below.

1.5.6 Mitigation Measures

The Navy implements mitigation to avoid or reduce potential impacts from the Proposed Action on marine mammals during numerous activities involving anti-submarine warfare, mine warfare, surface warfare, and other warfare components. Mitigation measures for marine mammals are designed to effect the least practicable adverse impact on marine mammal species or stocks and their habitat, and have a negligible impact on marine mammal species and stocks (as required under the MMPA), and to ensure that the Proposed Action does not jeopardize the continued existence of endangered or threatened species, or result in destruction or adverse modification of critical habitat (as required under the ESA). The Navy will implement mitigation for the training and testing activity categories, stressors, and geographic locations listed in Table 1-16 below as part of the Proposed Action. See Chapter 11 (Mitigation Measures) for a complete presentation of the procedural mitigation and mitigation areas that will be implemented under the Proposed Action.

Table 1-16: Summary of Mitigation Categories

Chapter 11 (Mitigation Measures) Section	***Applicable Stressor, Activity, or Location***
Section 11.1 (Procedural Mitigation)	Environmental Awareness and Education
Section 11.1.1 (Acoustic Stressors)	Low-Frequency Active Sonar Mid-Frequency Active Sonar High-Frequency Active Sonar Air Guns Pile Driving Weapons Firing Noise
Section 11.1.2 (Explosive Stressors)	Explosive Sonobuoys Explosive Torpedoes Explosive Medium-Caliber and Large-Caliber Projectiles Explosive Missiles and Rockets Explosive Bombs Sinking Exercises Explosive Mine Countermeasure and Neutralization Activities Explosive Mine Neutralization Activities Involving Navy Divers Underwater Demolition Multiple Charge – Mat Weave and Obstacle Loading Maritime Security Operations – Anti-Swimmer Grenades
Section 11.1.3 (Physical Disturbance and Strike Stressors)	Vessel Movement Towed In-Water Devices Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions Non-Explosive Missiles and Rockets Non-Explosive Bombs and Mine Shapes
Section 11.2 (Mitigation Areas)	Mitigation Areas for Seafloor Resources Mitigation Areas for Marine Mammals in the Hawaii Range Complex Mitigation Areas for Marine Mammals in the Southern California Portion of the Study Area

2 Dates, Duration, and Specified Geographic Region

Training and testing activities would be conducted in the HSTT Study Area throughout the year from the end of 2018 through the end of 2023. The number of annual and 5-year occurrences of the different training and testing activities can be found in the last columns of Tables 1-5 through 1-9. Also indicated is the specified region where the activity will occur within the Study Area. The Study Area is comprised of established operating and warning areas across the north-central Pacific Ocean, from the mean high tide line in Southern California west to Hawaii and the International Date Line. The Study Area includes the at-sea areas of three existing range complexes (the Hawaii Range Complex, the SOCAL Range Complex, and the Silver Strand Training Complex), and overlaps a portion of the Point Mugu Sea Range (PMSR). Also included in the Study Area are Navy pierside locations in Hawaii and Southern California, Pearl Harbor, San Diego Bay, and the transit corridor[4] on the high seas where sonar training and testing may occur. The Study Area and typical transit corridor are depicted in Figure 1-1. Within the Study Area, a range complex is a designated set of specifically bounded geographic areas that encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occurs. Range complexes include established operating areas (OPAREAs) and special use airspace, which may be further divided to provide safety and better control of the area and events being conducted.

- **Airspace**
  - **Special Use Airspace**. Airspace of defined dimensions where activities must be confined because of their nature or where limitations may be imposed upon aircraft operations that are not part of those activities (Federal Aviation Administration Order 7400.8). Types of special use airspace most commonly found in range complexes include the following:
    - **Restricted Areas:** Airspace where aircraft are subject to restriction due to the existence of unusual, often invisible hazards (e.g., release of ordnance) to aircraft. Some areas are under strict control of the Department of Defense (DoD) and some are shared with non-military agencies.
    - **Warning Area:** Areas of defined dimensions, extending from 3 NM outward from the coast of the United States, which serve to warn nonparticipating aircraft of potential danger.
    - **Air Traffic Controlled Assigned Airspace:** Airspace of defined vertical/lateral limits, assigned by Air Traffic Control, for the purpose of providing air traffic segregation between the specified activity being conducted within the assigned airspace and other instrument flight rules traffic.
- **Sea and Undersea Space**
  - **Surface Danger Zones:** A danger zone is a defined water area used for target practice, bombing, rocket firing, or other especially hazardous military activities. Danger zones are established pursuant to statutory authority of the Secretary of the Army and are administered by the Army Corps of Engineers. Danger zones may be closed to the public on a full-time or intermittent basis (33 Code of Federal Regulations 334).
  - **Restricted Areas:** A restricted area is a defined water area for the purpose of prohibiting or limiting public access to the area. Restricted areas generally provide security for Government property and/or protection to the public from the risks of damage or injury arising from the Government's use of that area (33 Code of Federal Regulations 334).

[4] Vessel transit corridors are the routes typically used by Navy assets to traverse from one area to another. The route depicted in Figure 1-1 is the shortest route between Hawaii and Southern California, making it the quickest and most fuel efficient. Depicted vessel transit corridor is notional and may not represent the actual routes used by ships and submarines transiting from Southern California to Hawaii and back. Actual routes navigated are based on a number of factors including, but not limited to, weather, training, and operational requirements.

2.1 HAWAII RANGE COMPLEX

The Hawaii Range Complex geographically encompasses ocean areas located around the Hawaiian Islands chain. The ocean areas extend from 16 degrees north latitude to 43 degrees north latitude and from 150 degrees west longitude to the International Date Line, forming an area approximately 1,700 NM by 1,600 NM.

The largest component of the Hawaii Range Complex is the Temporary OPAREA, extending north and west from the island of Kauai, and comprising over 2 million square nautical miles (NM^2) of air and sea space. The Temporary OPAREA is used primarily for missile testing by the Pacific Missile Range Facility, and those missile tests are not part of this LOA request. The Navy is not requesting a permit for any University, U.S. Air Force, or any other services' activities conducted in the Temporary OPAREA or from the Pacific Missile Range Facility. For this LOA request, this area is used for Navy ship transits throughout the year. Despite the Temporary OPAREA's size, nearly all of the training and testing activities in the Hawaii Range Complex take place within the smaller Hawaii OPAREA, that portion of the range complex immediately surrounding the island chain from Hawaii to Kauai (Figures 2-1 through 2-4). The Hawaii OPAREA consists of 235,000 NM^2 of special use airspace and ocean areas.

2.1.1 AIRSPACE

The Hawaii Range Complex includes over 115,000 NM^2 of combined special use airspace and air traffic control assigned airspace.

As depicted in Figure 2-1, this airspace is almost entirely over the ocean and includes warning areas, air traffic controlled assigned airspace, and restricted areas.

- Warning Areas of the Hawaii Range Complex make up more than 58,000 NM^2 of special use airspace and include the following: Warning Area (W)-186, W-187, W-188, W-189, W-190, W-191, W-192, W-193, W-194, and W-196.

- The air traffic controlled assigned airspace areas of the Hawaii Range Complex account for more than 57,000 NM^2 of special use airspace and include the following areas: Luna East, Luna Central, Luna West, Mahi, Haka, Mela South, Mela Central, Mela North, Nalu, Taro, Kaela East, Kaela West, Pele, and Pele South.

- The restricted area airspace over or near land areas within the Hawaii Range Complex makes up another 81 NM^2 of special use airspace and includes R-3101, R-3103, and R-3107. Kaula Island is located completely within R-3107, west-southwest of Kauai.

This request will include analysis of only the marine environment surrounding Kaula Island, and not potential impacts on the island itself. Aerial survey data indicates 10-15 Hawaiian monk seals (Neomonachus schauinslandi) hauled out on Kaula Island, making it likely they are common to the surrounding nearshore waters (Richie et al., 2012). This information was considered in the analysis of potential impacts to Hawaiian monk seals.

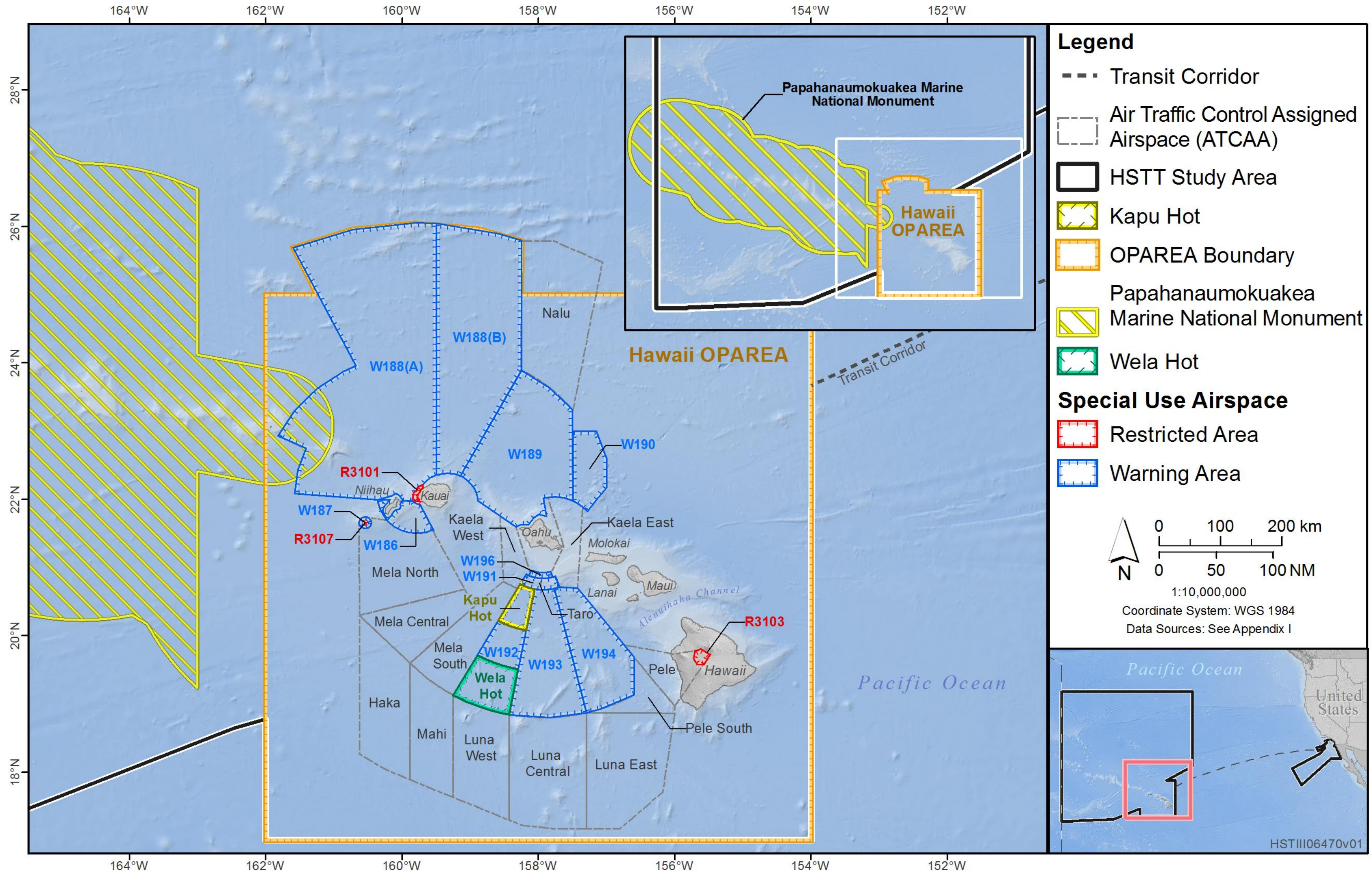

Figure 2-1: Hawaii Operating Area

Notes: HSTT = Hawaii-Southern California Training and Testing, OPAREA = Operating Area

2.1.2 SEA AND UNDERSEA SPACE

The Hawaii Range Complex includes the ocean areas as described above, as well as specific training areas around the islands of Kauai, Oahu, and Maui (Figures 2-2, 2-3, and 2-4 respectively). The Hawaii Range Complex also includes the ocean portion of the Pacific Missile Range Facility (PMRF) on Kauai, which is both a fleet training range and a fleet and DoD testing range. The facility includes 1,100 NM^2 of instrumented ocean area at depths between 129 ft. and 15,000 ft.

The Hawaii Range Complex also includes the ocean areas around the designated Papahanaumokuakea Marine National Monument, referred hereafter as the Monument. Establishment of the Monument in June 2006 triggered a number of prohibitions on activities conducted in the Monument area. However, all military activities and exercises were specifically excluded from the listed prohibitions as long as the military exercises and activities are "carried out in a manner that avoids, to the extent practicable and consistent with operational requirements, adverse impacts on monument resources and qualities." In 2016, the Monument was expanded from its original 139,818 square miles ($mi.^2$) to 582,578 $mi.^2$ The expansion of the Monument was primarily to the west—away from the portion of the Hawaii Range Complex where most training and testing activities are proposed to occur—and did not affect the military exclusion from the listed prohibitions.

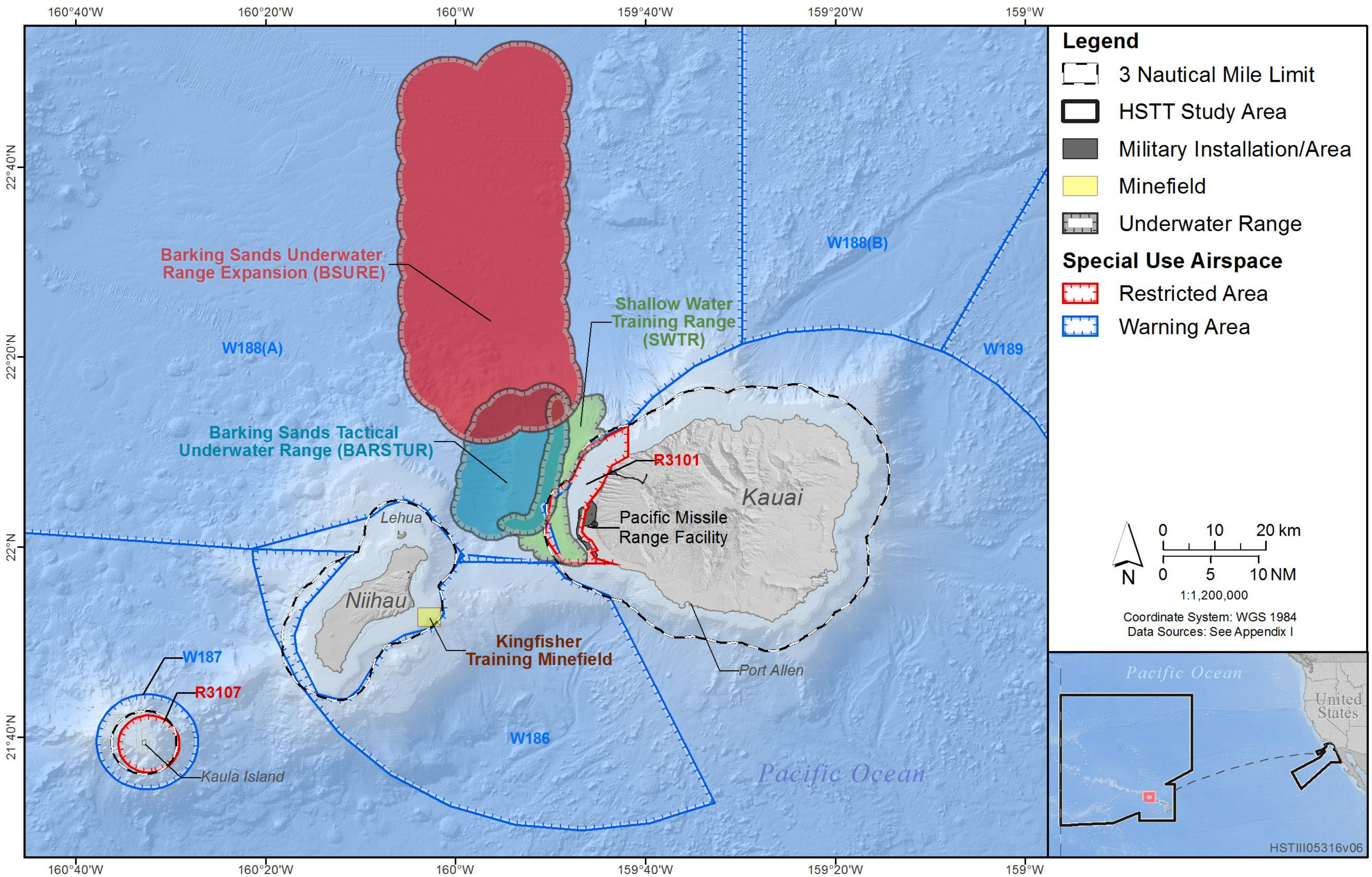

Figure 2-2: Navy Training and Testing Areas Around Kauai

Notes: HSTT = Hawaii-Southern California Training and Testing

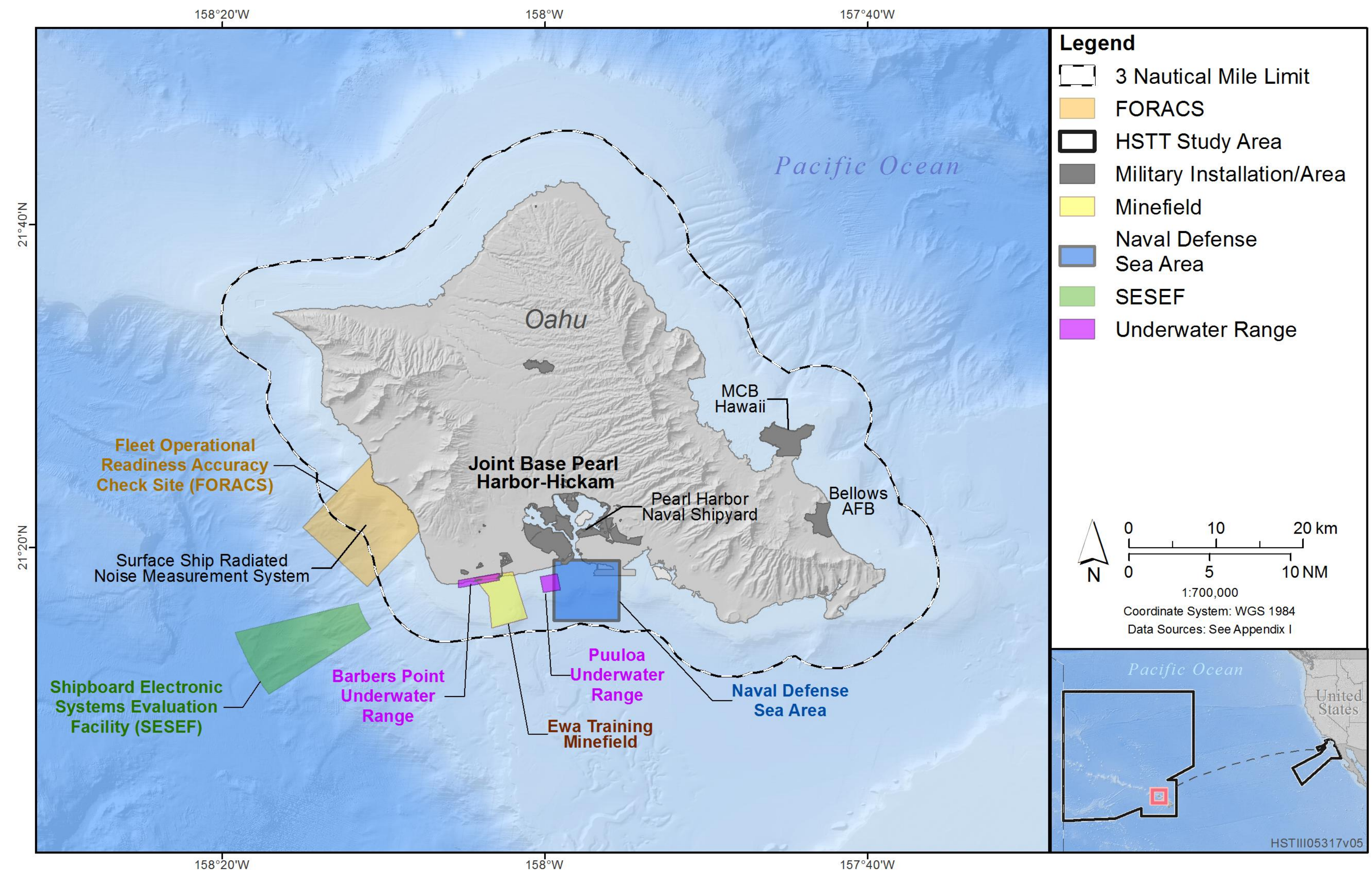

Figure 2-3: Navy Training and Testing Areas Around Oahu

Notes: HSTT = Hawaii-Southern California Training and Testing, AFB = Air Force Base, MCB = Marine Corps Base

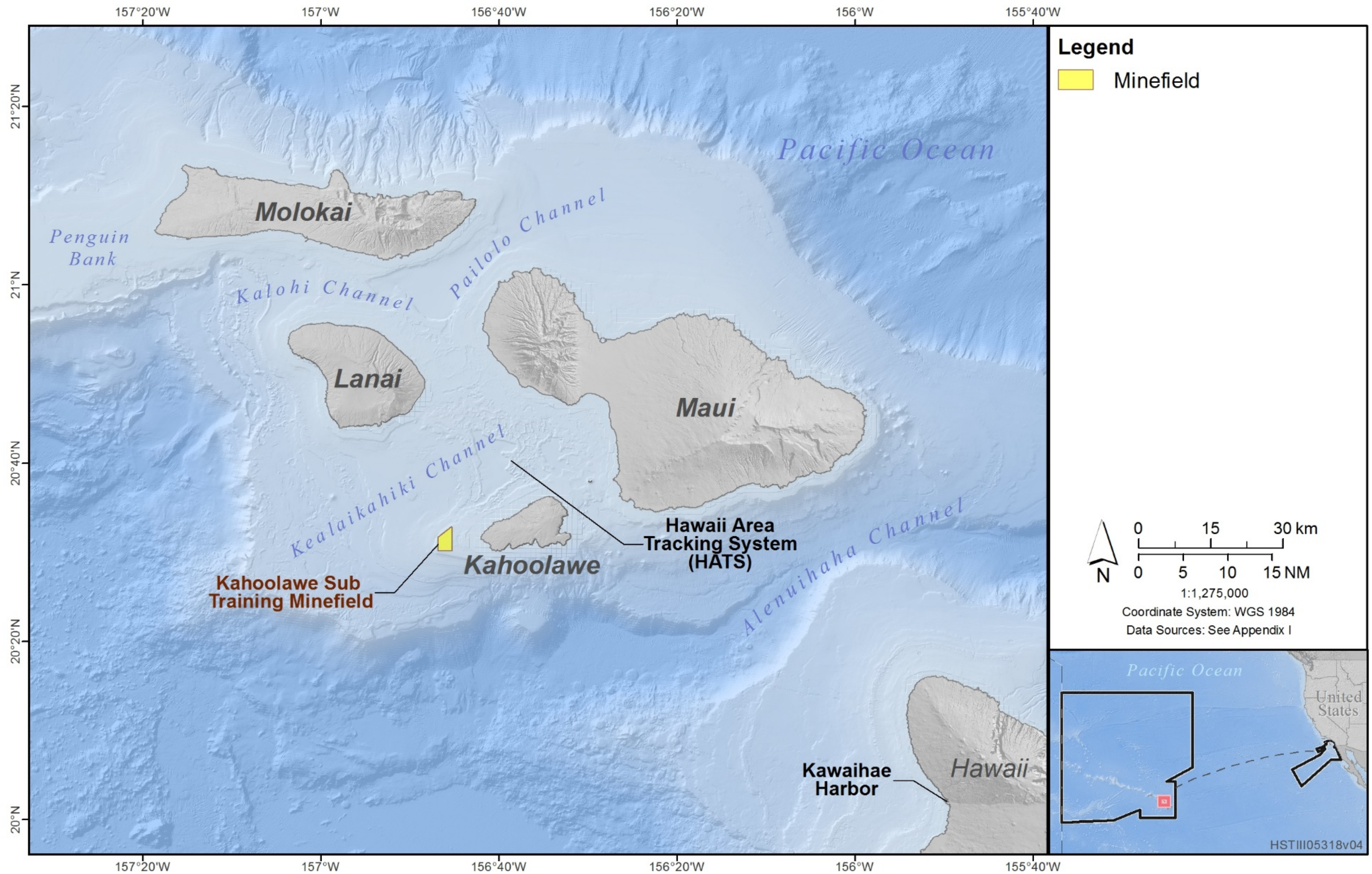

Figure 2-4: Navy Training and Testing Areas Around Maui

2.2 SOUTHERN CALIFORNIA RANGE COMPLEX

The SOCAL Range Complex is located approximately between Dana Point and San Diego, and extends southwest into the Pacific Ocean (Figures 2-5, 2-6, and 2-7). Although the range complex extends more than 600 NM beyond land, most activities occur with 200 NM of Southern California. The two primary components of the SOCAL Range Complex are the ocean OPAREAs and the special use airspace. These components encompass 120,000 NM^2 of sea space and 113,000 NM^2 of special use airspace.

2.2.1 SPECIAL USE AIRSPACE

Most of the special use airspace in the SOCAL Range Complex is defined by W-291 (Figure 2-5). This warning area extends vertically from the ocean surface to 80,000 ft. above mean sea level and encompasses 113,000 NM^2 of airspace. In addition to W-291, the SOCAL Range Complex includes the following three areas:

- Western San Clemente OPAREA is a special use airspace that extends from the surface to 5,000 ft. above mean sea level.
- Two Helicopter Offshore Training Areas located off the coast of San Diego, which extend from the surface to 1,000 ft. above mean sea level.

2.2.2 SEA AND UNDERSEA SPACE

The SOCAL Range Complex includes approximately 120,000 NM^2 of sea and undersea space, largely defined as that ocean area underlying the Southern California special use airspace described above. The SOCAL Range Complex also extends beyond this airspace to include the surface and subsurface area from the northeastern border of W-291 to the coast of San Diego County, and includes San Diego Bay.

2.3 POINT MUGU SEA RANGE OVERLAP

A small portion (approximately 1,000 NM^2) of the Point Mugu Sea Range (hereafter referred to as the "Point Mugu Sea Range overlap") is included in the Study Area (Figure 2-5). Only that part of the Point Mugu Sea Range is used by the Navy for anti-submarine warfare training; this training uses sonar, is conducted in the course of major training exercises, and is analyzed in this request. Other non-dependent and non-connected activities at the Point Mugu Sea Range, including San Nicolas Island, are addressed through separate documentation.

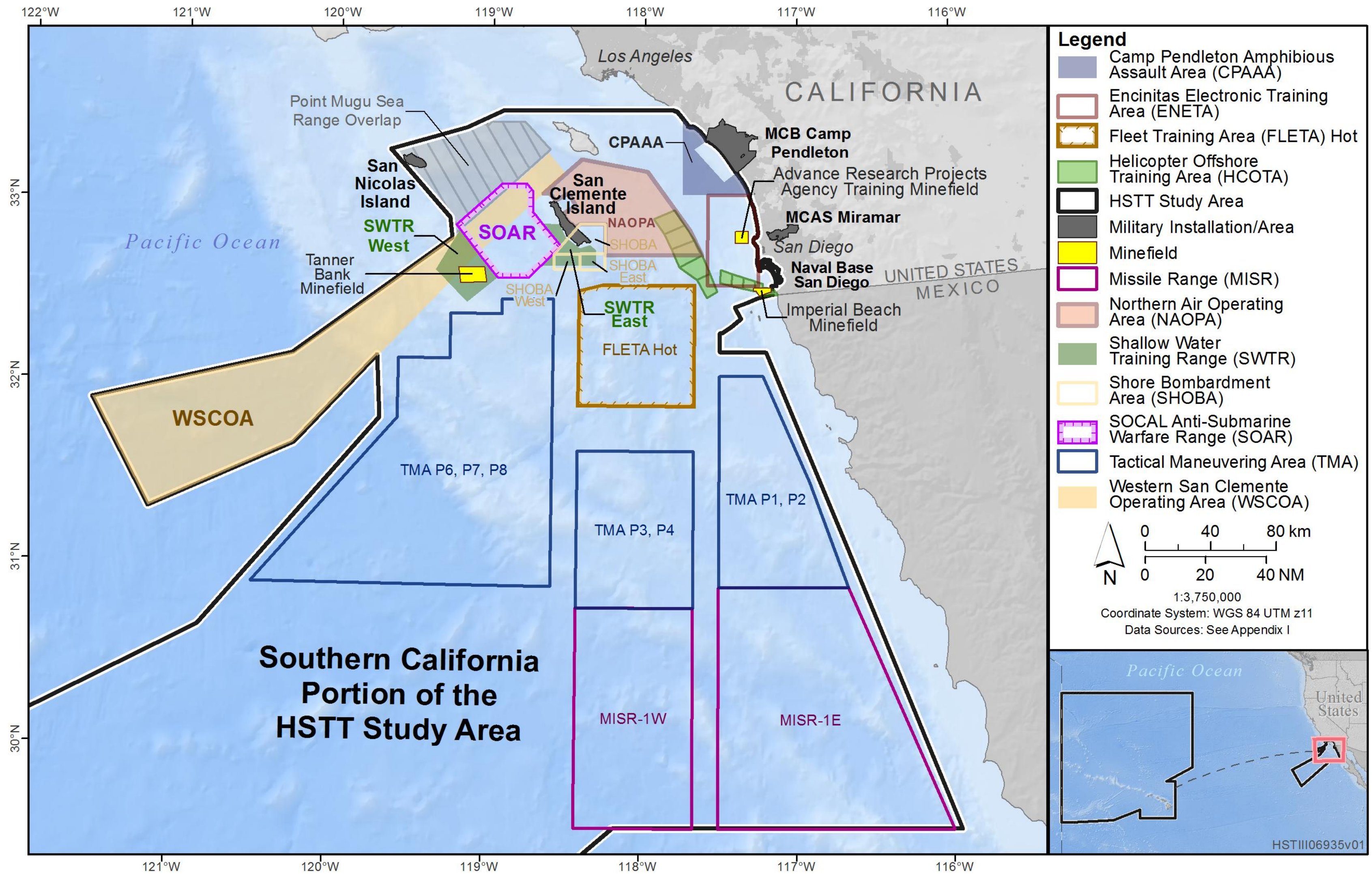

Figure 2-5: Southern California Training and Testing Areas

Notes: HSTT = Hawaii-Southern California Training and Testing

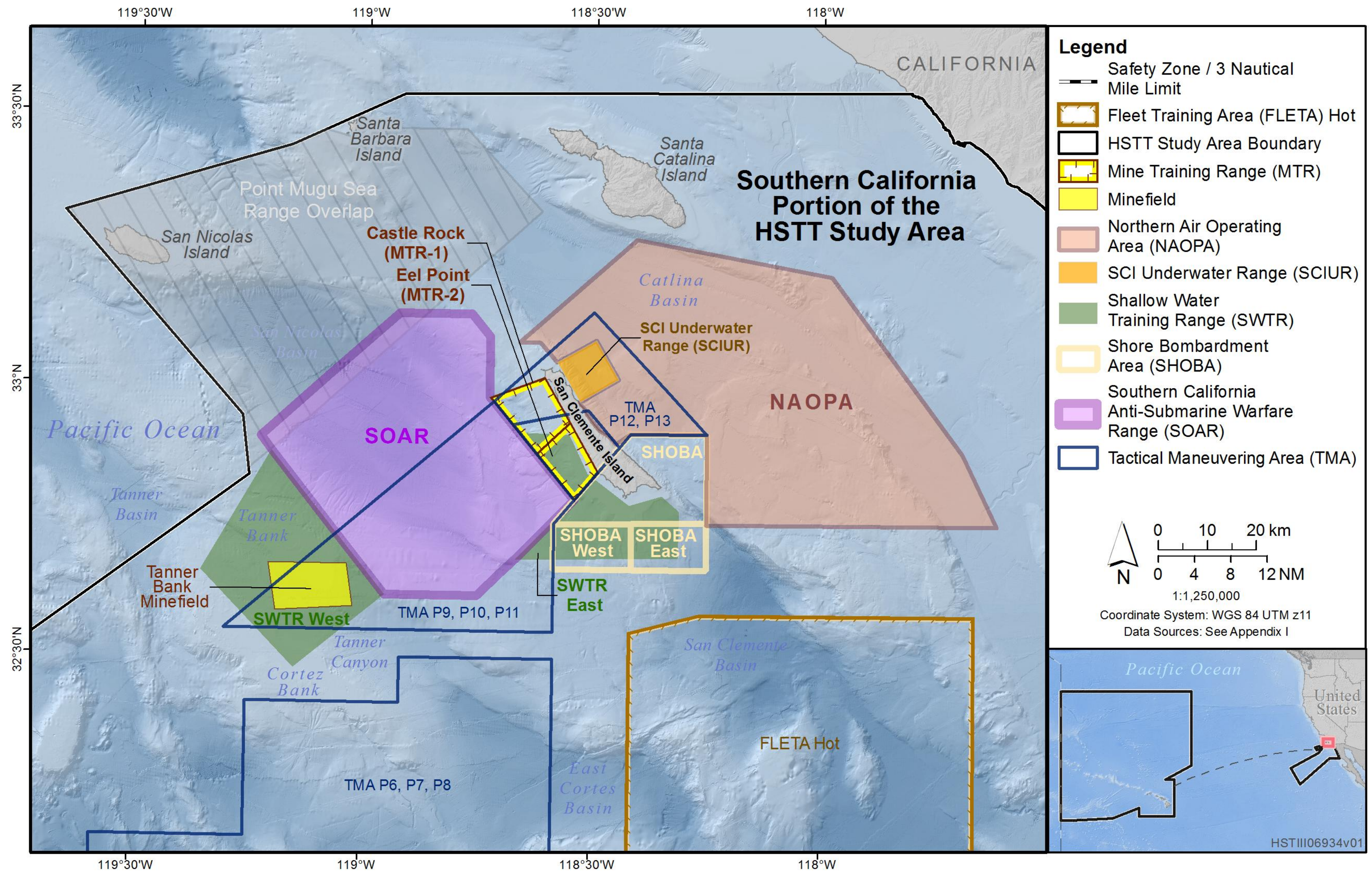

Figure 2-6: San Clemente Island Offshore Training and Testing Areas

Notes: HSTT = Hawaii-Southern California Training and Testing, SCI = San Clemente Island

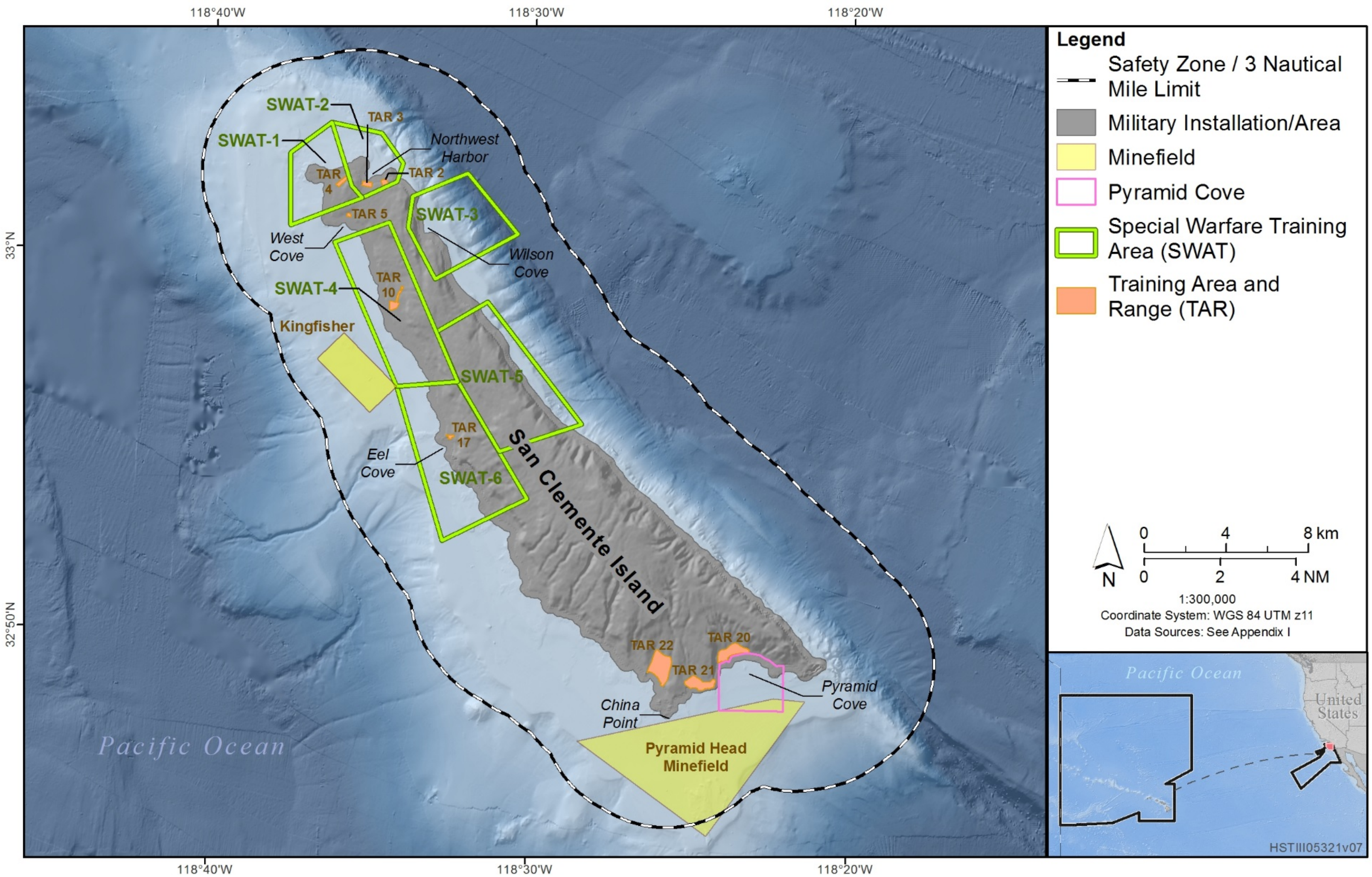

Figure 2-7: San Clemente Island Nearshore Training and Testing Areas

2.4 Silver Strand Training Complex

The Silver Strand Training Complex is an integrated set of training areas located on and adjacent to the Silver Strand, a narrow, sandy isthmus separating the San Diego Bay from the Pacific Ocean. It is divided into two non-contiguous areas: Silver Strand Training Complex-North and Silver Strand Training Complex-South (Figure 2-8)

The Silver Strand Training Complex-North includes 10 oceanside boat training lanes (numbered as Boat Lanes 1–10), ocean anchorage areas (numbered 101–178), bayside water training areas (Alpha through Hotel), and the Lilly Ann drop zone. The boat training lanes are each 500 yards (yd.) wide stretching 4,000 yd. seaward and forming a 5,000 yd. long contiguous training area. The Silver Strand Training Complex-South includes four oceanside boat training lanes (numbered as Boat Lanes 11–14) and the TA-Kilo training area.
The anchorages lie offshore of Coronado in the Pacific Ocean and overlap a portion of Boat Lanes 1–10. The anchorages are each 654 yd. in diameter and are grouped together in an area located primarily due west of Silver Strand Training Complex-North, east of Zuniga Jetty and the restricted areas on approach to the San Diego Bay entrance.

2.5 Ocean Operating Areas Outside the Bounds of Existing Range Complexes (Transit Corridor)

In addition to the range complexes that are part of the Study Area, a transit corridor outside the boundaries of the range complexes will also be included as part of the Study Area in the analysis. Although not part of any defined range complex, this transit corridor is important to the Navy in that it provides adequate air, sea, and undersea space in which vessels and aircraft conduct training and some sonar maintenance and testing while enroute between Southern California and Hawaii.

The transit corridor, notionally defined by the great circle route (e.g., shortest distance) from San Diego to the center of the Hawaii Range Complex, as depicted in Figure 1-1, is generally used by ships transiting between the Southern California Range Complex and Hawaii Range Complex. While in transit, ships and aircraft would, at times, conduct basic and routine unit level activities such as gunnery, bombing, and sonar training, testing, and maintenance, as long as the activities do not interfere with the primary objective of reaching their intended destination.

2.6 Pierside Locations, Pearl Harbor, and San Diego Bay

The Study Area includes select pierside locations where Navy surface ship and submarine sonar maintenance testing occur. For purposes of this LOA request, pierside locations include channels and routes to and from Navy ports, and facilities associated with Navy ports and shipyards. These locations in the Study Area are located at Navy ports and naval shipyards in Pearl Harbor, Hawaii and in San Diego Bay, California (Figure 2-9). In addition, some training and testing activities occur throughout San Diego Bay.

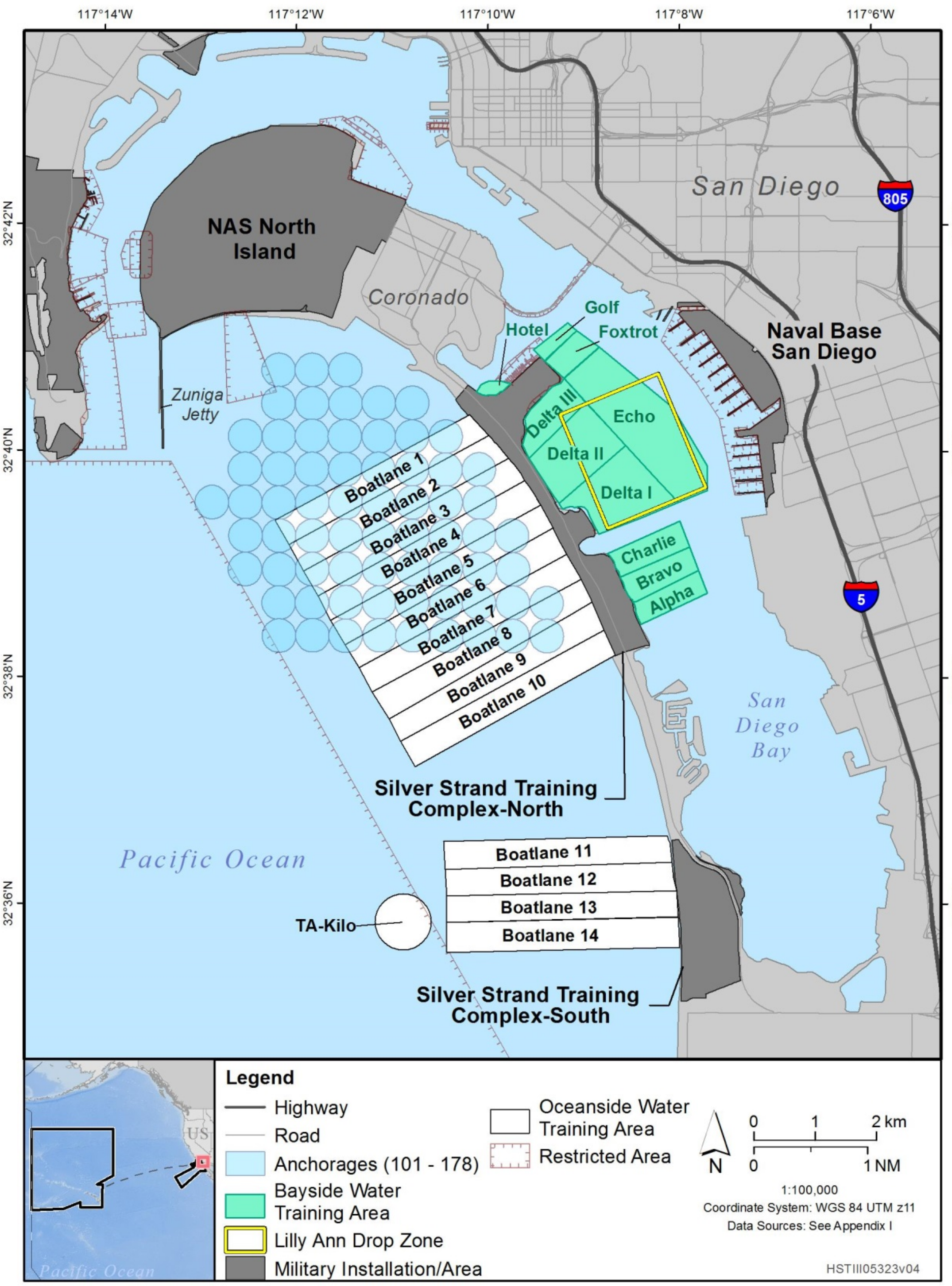

Figure 2-8: Silver Strand Training Complex

Notes: NAS = Naval Air Station, TA = Training Area

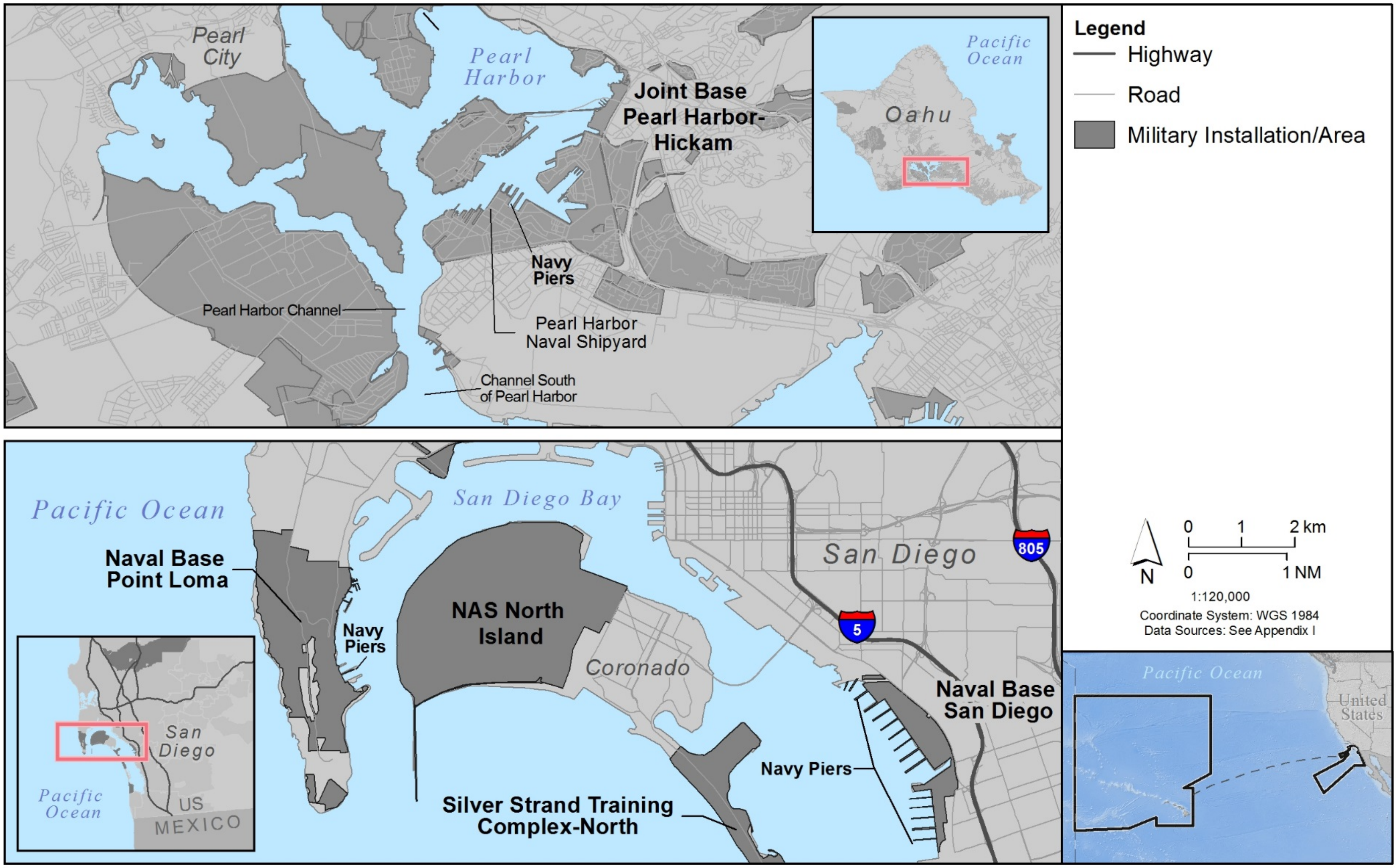

Figure 2-9: Navy Piers and Shipyards in the Study Area

Notes: NAS = Naval Air Station

3 Species and Numbers of Marine Mammals

Thirty-eight marine mammal species are known to occur in the HSTT Study Area, including 7 mysticetes (baleen whales), 24 odontocete species (dolphins and toothed whales), 1 odontocete species group (Mesoplodent beaked whales), and 6 pinnipeds (seals and sea lions). Among these species there are multiple stocks managed by NMFS in the United States Exclusive Economic Zone.

These species and stocks are presented in Table 3-1 along with an abundance estimate, an associated coefficient of variation value, and minimum abundance, all based upon the final 2016 Stock Assessment Reports from NMFS (Carretta et al., 2017; Muto et al., 2017). For each species and stock, relevant information on their status, distribution, population trends, and ecology is presented in Chapter 4.

Table 3-1: Marine Mammals Occurrence Within the HSTT Study Area

Common Name	Scientific Name	Stock	Status		Occurrence	Seasonal Absence	Stock Abundance (CV)/Minimum Population
			MMPA	ESA			
Blue whale	*Balaenoptera musculus*	Eastern North Pacific	Depleted	Endangered	Southern California	-	1,647 (0.07)/1,551
		Central North Pacific	Depleted	Endangered	Hawaii	Summer	81 (1.14)/38
Bryde's whale	*Balaenoptera brydei/edeni*	Eastern Tropical Pacific	-	-	Southern California	-	unk
		Hawaiian	Depleted	-	Hawaii	-	798 (0.28)/633
Fin whale	*Balaenoptera physalus*	California, Oregon, and Washington	Depleted	Endangered	Southern California	-	9,029 (0.12)/8,127
		Hawaiian	Depleted	Endangered	Hawaii	Summer	58 (1.12)/27
Gray whale	*Eschrichtius robustus*	Eastern North Pacific	-	-	Southern California	-	20,990 (0.05)/20,125
		Western North Pacific	Depleted	Endangered	Southern California	-	140 (0.04)/135
Humpback whale	*Megaptera novaeangliae*	California, Oregon, Washington	Depleted	Threatened/ Endangered[1]	Southern California	-	1,918 (0.03)/1,876
		Central North Pacific	-	-	Hawaii	Summer	10,103 (0.30)/7,890

[1]The two humpback whale Distinct Population Segments making up the California, Oregon, and Washington stock present in Southern California are the Mexico Distinct Population Segment, listed under ESA as Threatened, and the Central America Distinct Population Segment, which is listed under ESA as Endangered.

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name	Stock	Status		Occurrence	Seasonal Absence	Stock Abundance (CV)/Minimum Population
			MMPA	ESA			
Minke whale	*Balaenoptera acutorostrata*	California, Oregon, and Washington	-	-	Southern California	-	636 (0.72)/369
		Hawaiian	-	-	Hawaii	Summer	unk
Sei whale	*Balaenoptera borealis*	Eastern North Pacific	Depleted	Endangered	Southern California	-	519 (0.4)/374
		Hawaii	Depleted	Endangered	Hawaii	Summer	178 (0.90)/93
Sperm whale	*Physeter macrocephalus*	California, Oregon, and Washington	Depleted	Endangered	Southern California	-	2,106 (0.58)/1,332
		Hawaiian	Depleted	Endangered	Hawaii	-	3,354 (0.34)/2,539
Pygmy sperm whale	*Kogia breviceps*	California, Oregon, and Washington	-	-	Southern California	Winter & Fall	4,111 (1.12)/1,924
		Hawaiian	-	-	Hawaii	-	unk
Dwarf sperm whale	*Kogia sima*	California, Oregon, and Washington	-	-	Southern California	-	unk
		Hawaiian	-	-	Hawaii	-	unk
Baird's beaked whale	*Berardius bairdii*	California, Oregon, and Washington	-	-	Southern California	-	847 (0.81)/466
Blainville's beaked whale	*Mesoplodon densirostris*	Hawaiian	-	-	Hawaii	-	2,338 (1.13)/1,088

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name	Stock	Status		Occurrence	Seasonal Absence	Stock Abundance (CV)/Minimum Population
			MMPA	ESA			
Cuvier's beaked whale	*Ziphius cavirostris*	California, Oregon, and Washington	-	-	Southern California	-	6,590 (0.55)/4,481
		Hawaiian	-	-	Hawaii	-	1,941 na/1,142
Longman's beaked whale	*Indopacetus pacificus*	Hawaiian	-	-	Hawaii	-	4,571 (0.65)/2,773
Mesoplodont beaked whales[6]	*Mesoplodon spp.*	California, Oregon, and Washington	-	-	Southern California	-	694 (0.65)/389
Common Bottlenose dolphin	*Tursiops truncatus*	California Coastal	-	-	Southern California	-	453 (0.06)/346
		California, Oregon, and Washington Offshore	-	-	Southern California	-	1,924 (0.54)/1,255
		Hawaiian Pelagic	-	-	Hawaii	-	5,950 (0.59)/3,755
		Kauai and Niihau	-	-	Hawaii	-	184 (0.11)/168
		Oahu	-	-	Hawaii	-	743 (0.54)/485
		4-Islands	-	-	Hawaii	-	191 (0.24)/156
		Hawaii Island	-	-	Hawaii	-	128 (0.13)/115

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name	Stock	Status		Occurrence	Seasonal Absence	Stock Abundance (CV)/Minimum Population
			MMPA	ESA			
False killer whale	*Pseudorca crassidens*	Main Hawaiian Islands Insular	Depleted	Endangered	Hawaii	-	151 (0.20)/92
		Hawaii Pelagic	-	-	Hawaii	-	1,540 (0.66)/928
		Northwestern Hawaiian Islands	-	-	Hawaii	-	617 (1.11)/290
Fraser's dolphin	*Lagenodelphis hosei*	Hawaiian	-	-	Hawaii	-	16,992 (0.66)/10,241
Killer whale	*Orcinus orca*	Eastern North Pacific Offshore	-	-	Southern California	-	240 (0.49)/162
		Eastern North Pacific Transient/West Coast Transient[2]	-	-	Southern California	-	243 unk/243
		Hawaiian	-	-	Hawaii	-	101 (1.00)/50
Long-beaked common dolphin	*Delphinus capensis*	California	-	-	Southern California	-	101,305 (0.49)/68,432
Melon-headed whale	*Peponocephala electra*	Hawaiian Islands	-	-	Hawaii	-	5,794 (0.20)/4,904
		Kohala Resident	-	-	Hawaii	-	447 (0.12)/404
Northern right whale dolphin	*Lissodelphis borealis*	California, Oregon, & Washington	-	-	Southern California	-	26,556 (0.44)/18,608

[2]This stock is mentioned briefly in the Pacific Stock Assessment Report (Carretta et al., 2017) and referred to as the "Eastern North Pacific Transient" stock, however, the Alaska Stock Assessment Report contains assessments of all transient killer whale stocks in the Pacific and the Alaska Stock Assessment Report refers to this same stock as the "West Coast Transient" stock (Muto et al., 2017).

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	Scientific Name	Stock	Status		Occurrence	Seasonal Absence	Stock Abundance (CV)/Minimum Population
			MMPA	ESA			
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	California, Oregon, & Washington	-	-	Southern California	-	26,814 (0.28)/21,195
Pantropical spotted dolphin	*Stenella attenuata*	Oahu	-	-	Hawaii	-	unk
		4-Islands	-	-	Hawaii	-	unk
		Hawaii Island	-	-	Hawaii	-	unk
		Hawaii Pelagic	-	-	Hawaii	-	15,917 (0.40)/11,508
Pygmy killer whale	*Feresa attenuata*	Tropical	-	-	Southern California	Winter & Spring	na
		Hawaiian	-	-	Hawaii	-	3,433 (0.52)/2,274
Risso's dolphins	*Grampus griseus*	California, Oregon, & Washington	-	-	Southern California	-	6,336 (0.32)/4,817
		Hawaiian	-	-	Hawaii	-	7,256 (0.41)/5,207
Rough-toothed dolphin	*Steno bredanensis*	na[3]	-	-	Southern California	-	unk
		Hawaiian	-	-	Hawaii	-	6,288 (0.39)/4,581
Short-beaked common dolphin	*Delphinus delphis*	California, Oregon, and Washington	-	-	Southern California	-	969,861 (0.17)/839,325

[3]Rough-toothed dolphin has a range known to include the waters off Southern California, but there is no recognized stock or data available for the U.S west coast.

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	***Scientific Name***	***Stock***	***Status***		***Occurrence***	***Seasonal Absence***	***Stock Abundance (CV)/Minimum Population***
			MMPA	***ESA***			
Short-finned pilot whale	*Globicephala macrorhynchus*	California, Oregon, & Washington	-	-	Southern California	-	836 (0.79)/466
		Hawaiian	-	-	Hawaii	-	12,422 (0.43)/8,782
Spinner dolphin	*Stenella longirostris*	Hawaii Pelagic	-	-	Hawaii	-	unk
		Hawaii Island	-	-	Hawaii	-	631 (0.04)/585
		Oahu and 4-Islands	-	-	Hawaii	-	355 (0.09)/329
		Kauai and Niihau	-	-	Hawaii	-	601 (0)/509
		Kure and Midway	-	-	Hawaii	-	unk
		Pearl and Hermes	-	-	Hawaii	-	unk
Striped dolphin	*Stenella coeruleoalba*	California, Oregon, and Washington	-	-	Southern California	-	29,211 (0.20)/24,782
		Hawaiian	-	-	Hawaii	-	20,650 (0.36)/15,391
Dall's porpoise	*Phocoenoides dalli*	California, Oregon, and Washington	-	-	Southern California	-	25,750 (0.45)/17,954
Harbor seal	*Phoca vitulina*	California	-	-	Southern California	-	30,968 na/27,348

Table 3-1: Marine Mammals Occurrence within the HSTT Study Area (continued)

Common Name	***Scientific Name***	***Stock***	***Status***		***Occurrence***	***Seasonal Absence***	***Stock Abundance (CV)/Minimum Population***
			MMPA	***ESA***			
Hawaiian monk seal	*Neomonachus schauinslandi*	Hawaiian	Depleted	Endangered	Hawaii	-	1,272 na/1,205
Northern elephant seal	*Mirounga angustirostris*	California	-	-	Southern California	-	179,000 na/81,368
California sea lion	*Zalophus californianus*	U.S. Stock	-	-	Southern California	-	296,750 na/153,337
Guadalupe fur seal	*Arctocephalus townsendi*	Mexico to California	Depleted	Threatened	Southern California	-	20,000 na/15,830
Northern fur seal	*Callorhinus ursinus*	California	-	-	Southern California	-	14,050 na/7,524

4 Affected Species Status and Distribution

4.1 Marine Mammal Species

The marine mammal species discussed in this section are those for which general regulations governing potential incidental takes of small numbers of marine mammals are sought. Relevant information on their status, distribution, and seasonal distribution (when applicable) is presented below, as well as additional information about the numbers of marine mammals likely to be found within the activity areas. Information on the general biology and ecology of marine mammals is beyond the scope of this request and is included in the HSTT Draft EIS/OEIS (U.S. Department of the Navy, 2017). In addition, NMFS annually publishes stock assessment reports for all marine mammals in U.S. Exclusive Economic Zone waters, including stocks that occur within the HSTT Study Area.

4.1.1 Blue Whale (*Balaenoptera musculus*)

4.1.1.1 Status and Management

The world's population of blue whales can be separated into three subspecies, based on geographic location and some morphological differences. In the HSTT Study Area, the subspecies *Balaenoptera musculus musculus* is present. The blue whale is listed as endangered under the ESA and as depleted under the MMPA throughout its range, but there is no designated critical habitat for this species.

4.1.1.2 Habitat and Geographic Range

Blue whales inhabit all oceans and typically occur near the coast, over the continental shelf, though they are also found in oceanic waters having been sighted, acoustically recorded, and satellite tagged in the eastern tropical Pacific (Ferguson, 2005; Stafford et al., 2004).

Blue whales from the Central North Pacific stock are found in the Hawaii portion of the Study Area, but the sighting frequency is low and the peak abundance is seasonal occurring in the winter (Bradford et al., 2013). Whales feeding along the Aleutian Islands and in the Gulf of Alaska likely migrate to Hawaii in winter (Stafford et al., 2001). In the winter of 2014–2015 (December to January), passive acoustic detections of blue whales were recorded intermittently over the 3-week period of the survey (Klinck et al., 2015).

The Eastern North Pacific Stock of blue whales includes animals found in the eastern north Pacific from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al., 2017). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. west coast, relatively high densities of blue whales are predicted off southern California during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2016; Forney et al., 2012). Data from year-round surveys conducted off southern California from 2004 to 2013 show that the majority of blue whales were sighted in summer (62 sightings) and fall (9 sightings), with only single sightings in winter and spring (Campbell et al., 2015). In the Southern California Bight in summer and fall, the highest densities of blue whales occurred along the 200-m isobath in waters with high surface chlorophyll concentrations (Redfern et al., 2013). Campbell et al. (2015) documented blue whale sighting along both the Southern Califorinia shelf, and over deep ocean water (>2,000 m). This species has also frequently been heard on passive acoustic recording devices in the Southern California portion of the Study Area (Širović et al., 2015). Based on approximately 3 million detections in the waters of the Southern California Bight between 2006 and 2012, Širović et al. (2015) found that blue whale vocalizations were more common at coastal sites and near the northern Channel Islands and generally heard between June and January with

a peak in September. There was large variation among blue whales tagged in the Southern California portion of the HSTT Study Area with the distance to shore ranging from less than 1 kilometer (km) and up to 884.8 km and blue whale movement along the Pacific coastline extending south to just 7.4 degrees north latitude (just north of the equator and north to 50 degrees north latitude just off British Colombia, Canada (Mate et al., 2015a). Data from a number of years and sources (Calambokidis et al., 2009a; Calambokidis & Barlow, 2013; Douglas et al., 2014b; Irvine et al., 2014; Mate et al., 2016a) consistently indicate large interannual variability in blue whale presence in small specific areas. Recent tagging data from blue whales in Southern California waters indicate the area of highest use for blue whales was between Point Dume and Mugu Canyon (north of the HSTT Study Area), out to approximately 30 km from shore (Mate et al., 2015a; Mate et al., 2016a).

Most blue whale sightings are in nearshore and continental shelf waters; however, blue whales frequently travel through deep oceanic waters during migration (Širović et al., 2004). Most baleen whales spend their summers feeding in productive waters near the higher latitudes and winters in the warmer waters at lower latitudes (Širović et al., 2004). Blue whales in the eastern north Pacific are known to migrate between higher latitude feeding grounds of the Gulf of Alaska and the Aleutian Islands to lower latitudes including Southern California, Baja California, Mexico and the Costa Rica Dome (Calambokidis & Barlow, 2004; Calambokidis et al., 2009a; Calambokidis et al., 2009b; Mate et al., 2015a; Mate et al., 2016b). The west coast is known to be a blue whale feeding area for the Eastern North Pacific stock during summer and fall (Bailey et al., 2009; Calambokidis et al., 2009a; Calambokidis et al., 2015a; Mate et al., 2015c). Photographs of blue whales off California have been matched to individuals photographed off the Queen Charlotte Islands in northern British Columbia and the northern Gulf of Alaska (Calambokidis et al., 2009a) and satellite tag data has also demonstrated this link between these areas (Mate et al., 2015c). These animals have shown site fidelity, returning to their mother's feeding grounds on their first migration (Calambokidis & Barlow, 2004).

There have been nine feeding areas identified for blue whales off the U.S. west coast (Calambokidis et al., 2015a). Of these nine, only four have overlap with the HSTT Study Area. Two of these feeding areas (the Santa Monica Bay to Long Beach feeding area and the San Nicolas Island feeding area) are at the extreme northern edge and slightly overlap with the Southern California portion of the HSTT Study Area. The remaining two feeding areas (the Tanner-Cortes Bank and the San Diego feeding areas) are entirely within the Southern California portion of the HSTT Study Area (Calambokidis et al., 2015a). The feeding behavior for which these areas are designated occurs from June to October (Aquatic Mammals, 2015; Calambokidis et al., 2015a). The blue whale feeding areas identified in waters extending from Point Conception to the Mexico border represent only a fraction of the total area within those waters where habitat models predict high densities of blue whales (Calambokidis et al., 2015a). Additionally, while those habitat models represent the areas tending to have the highest blue whale density when averaged over many years, the individual areas may not reflect the actual density present in any one given season or shorter time period considered. For example, tagging efforts in July 2016 focusing on blue and fin whales had to be shifted north to Central California waters when the majority of blue, fin, and humpback whales encountered were found to be too thin or otherwise in poor body condition in Southern California waters (Oregon State University, 2017). In Central California waters, the researchers identified good numbers of blue, fin, and humpback whales in better condition and indicative of a good feeding area that was likely to be sustained (Oregon State University, 2017). Appendix K of the HSTT Draft EIS/OEIS provides a detailed analysis of the potential effects of Navy training and testing on the identified blue whale feeding area.

4.1.1.3 Population Trends

Widespread whaling over the last century is believed to have decreased the global blue whale population to approximately 1 percent of its pre-whaling population size (Branch, 2007; Monnahan, 2013; Monnahan et al., 2014; Rocha et al., 2014; Širović et al., 2004). Off the Pacific Coast, there was a documented increase in the blue whale population size between 1979–80 and 1991 (Barlow, 1994) and between 1991 and 1996 (Barlow, 1997). Based on subsequent line-transect surveys conducted off the Pacific Coast between 2001 and 2005, the abundance estimates of blue whales appeared to decline in those waters over the survey period (Barlow & Forney, 2007). However, this apparent decline was likely due to variability in the distribution patterns of blue whales off the coast of North America rather than a true population decline (Barlow, 2010; Calambokidis et al., 2009a). Calambokidis et al. (2009a) suggested that when feeding conditions off California are not optimal, blue whales may move to other regions to feed, including waters further north. A comparison of survey data from the 1990s to 2008 indicates that there has been a northward shift in blue whale distribution within waters off California, Oregon, and Washington (Barlow, 2010; Širović et al., 2015). Consistent with the earlier suggested variability in the distribution patterns, Carretta et al. (2013a report that blue whales from the U.S. west coast have been increasingly found feeding to the north and south of the U.S. west coast during summer and fall. Subsequent mark-recapture estimates reported on by Calambokidis et al. (2009a), "indicated a significant upward trend in abundance of blue whales" at a rate of increase just under 3 percent per year for the U.S. west coast blue whale population in the Pacific (see also Calambokidis and Barlow (2013).

The most current information suggests that the population in the HSTT Study Area may have recovered and has been at a stable level following the cessation of commercial whaling in 1971 despite the impacts of ship strikes, interactions with fishing gear, and increased levels of ambient sound in the Pacific Ocean (Campbell et al., 2015; Carretta et al., 2015; Monnahan, 2013; Monnahan et al., 2014; Širović et al., 2015). Based on a comparison of sighting records from the 1950s to 2012 in the Southern California portion of the HSTT Study Area, Smultea and Jefferson (2014) determined that blue whales ranked sixth in occurrence which, "… represents a clear relative increase from historical records."

4.1.2 BRYDE'S WHALE (*BALAENOPTERA BRYDEI/EDENI*)

4.1.2.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. The International Whaling Commission recognizes three management stocks of Bryde's whales in the north Pacific: western north Pacific, eastern north Pacific, and East China Sea (Donovan, 1991), although the biological basis for defining separate stocks of Bryde's whales in the central north Pacific is not clear (Carretta et al., 2017). Current genetic research confirms that gene flow among Bryde's whale populations is low and suggests that management actions treat each as a distinct entity to ensure proper conservation of biological diversity (Kanda et al., 2007). Bryde's whales in Hawaii have been designated by NMFS as the Hawaiian stock and those in the Southern California portion of the HSTT Study Area are assigned to the Eastern Tropical Pacific stock (Carretta et al., 2017).

4.1.2.2 Habitat and Geographic Range

Bryde's whales were previously only occasionally sighted in Hawaiian waters (Carretta et al., 2010; Smultea et al., 2008). The first verified Bryde's whale sighting made nearshore of the main Hawaiian Islands occurred in 2007 (Smultea et al., 2008; Smultea et al., 2010). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the

sighting of three Bryde's/sei whales (Olsen et al., 2009). A summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone of the Hawaiian Islands resulted in 13 Bryde's whale sightings throughout the Study Area (Barlow, 2006). A total of 32 Bryde's whale sightings were made on a follow-up survey in 2010 (Bradford et al., 2017). Sightings had been more frequent in the northwest Hawaiian Islands than in the main Hawaiian Islands (Barlow, 2006; Smultea et al., 2008; Smultea et al., 2010). Based on predictive habitat-based density models derived from line-transect survey data collected between 1997 and 2012 within the central North Pacific, relatively high densities of Bryde's whales are predicted within the U.S. Exclusive Economic Zone of the Hawaiian Islands during the summer and fall, particularly in the northwest (Forney et al., 2015). Acoustic monitoring data collected using the Navy's instrumented training range hydrophones off the north coast of Kauai from August through October of 2014, allowed researchers to derive 17 Bryde's whale tracks as the vocalizing animals moved within the waters of the Navy range (Helble et al., 2016). Based on the Kauai acoustic data from 2014 with Bryde's whales detected as early as September, the species may be present year-round in Hawaii (Martin et al., 2017). Because Bryde's whales have been largely observed in deep offshore waters (Barlow, 2006; Bradford et al., 2017; Murase et al., 2015), detection of Bryde's whales closer to shore and further east in the last decade may be indicative of an overall shift in distribution for Bryde's whales in the North Pacific (Helble et al., 2016).

Bryde's whales were previously only occasionally sighted in the waters off Southern California (Carretta et al., 2010; Smultea, 2012; Smultea et al., 2011), but sightings and acoustic monitoring indicates an increase in the area so that the presence of the species is no longer considered anomalous (Carretta et al., 2017; Debich et al., 2015b; Kerosky et al., 2012; Smultea et al., 2010; Smultea et al., 2012b; Smultea & Jefferson, 2014). During aerial surveys conducted year-round between 2008 and 2013 off the Southern California coast, Bryde's whales were sighted on two occasions (Jefferson et al., 2014). These were the first sightings in this area since 1991 when a Bryde's whale was sighted within 300 NM of the California coast (Barlow, 1995). The peak in recorded Bryde's whale vocalizations has varied but generally occurs between late July and November in the Southern California portion of the HSTT Study Area (Debich et al., 2015a; Debich et al., 2015b; Kerosky et al., 2012).

Bryde's whales occur primarily in offshore oceanic waters of the north Pacific (Barlow, 2006; Bradford et al., 2017). They are distributed throughout the North Pacific Gyre and North Pacific Transition Zone, in the Hawaiian portion of the Study Area. Data suggest that winter and summer grounds partially overlap in the central north Pacific (Murase et al., 2015; Ohizumi, 2002; Ohizumi et al., 2002). Bryde's whales are distributed in the central north Pacific in summer; the southernmost summer distribution of Bryde's whales inhabiting the central north Pacific is about 20° North (N) (Kishiro, 1996). Some whales remain in higher latitudes (around 25° N) in both winter and summer, but are not likely to move poleward of 40° N (Jefferson et al., 2015; Kishiro, 1996). Bryde's whales in some areas of the world are sometimes seen very close to shore and even inside enclosed bays (Baker & Madon, 2007; Best, 1996.

Long migrations are not typical of Bryde's whales, although limited shifts in distribution toward and away from the equator, in winter and summer, have been observed (Best, 1996; Cummings, 1985).

4.1.2.3 Population Trends

Little is known of population status and trends for most Bryde's whale populations. However, a recent study suggests that the seasonal presence (summer to early winter) of Bryde's whale in the Southern California Bight has been increasing over the last decade (Kerosky et al., 2012).

4.1.3 Fin Whale (*Balaenoptera physalus*)

4.1.3.1 Status and Management

The fin whale is listed as depleted under the MMPA and endangered under the ESA, but there is no designated critical habitat for this species. Fin whale population structure in the Pacific Ocean is not well known. During the 20th century more fin whale were taken by industrialized whaling than any other species (Rocha et al., 2014). In the North Pacific, NMFS recognizes three fin whale stocks: (1) a Northeast Pacific stock in Alaska; (2) a California, Oregon, and Washington stock; and (3) a Hawaii stock (Allen & Angliss, 2014; Carretta et al., 2014a). Although some fin whales migrate seasonally (Falcone et al., 2011; Mate et al., 2015a; Mate et al., 2016b), NMFS does not recognize fin whales from the Northeast Pacific stock as being present in either Hawaii or Southern California.

4.1.3.2 Habitat and Geographic Range

The fin whale is found in all the world's oceans and is the second largest species of whale (Jefferson et al., 2015). Fin whales prefer temperate and polar waters and are scarcely seen in warm, tropical waters (Reeves et al., 2002a).

Fin whales are found in Hawaiian waters, but this species is considered to be rare in the Hawaii portion of the Study Area (Carretta et al., 2010; Shallenberger, 1981). There are known sightings from Kauai, Oahu, Hawaii and a single stranding record from Maui, Hawaii (Mobley et al., 1996; Shallenberger, 1981; U.S. Department of the Navy, 2011c). A single sighting was made during aerial surveys from 1993 to 1998, five sightings were made in offshore waters during a 2002 survey of waters within the Hawaiian Exclusive Economic Zone, and there were 2 fin whales sighted during a 2010 survey of the same area (Barlow, 2006; Bradford et al., 2017; Carretta et al., 2010; Mobley et al., 1996; Mobley et al., 2009). A single juvenile fin whale was reported off Kauai during Navy sponsored marine mammal research in 2011 (U.S. Department of the Navy, 2011d). Based on sighting data and acoustic recordings, fin whales are likely to occur in Hawaiian waters mainly in fall and winter (Barlow et al., 2004; Barlow, 2006; Barlow et al., 2008; Klinck et al., 2015).

This species has been documented from 60° N to 23° N and they have frequently been recorded in waters within the Southern California portion of the Study Area (Barlow & Forney, 2007; Campbell et al., 2015; Jefferson et al., 2014; Mate et al., 2016b, 2017; Mizroch et al., 2009; Širović et al., 2004; Širović et al., 2015; Širović et al., 2016; Smultea & Jefferson, 2014). As demonstrated by satellite tags and discovery tags, fin whales make long-range movements along the entire U.S. west coast (Falcone et al., 2011; Mate et al., 2015c; Mizroch et al., 2009). However, photo-identification studies of fin whales off the U.S. West Coast suggest that not all fin whales undergo long range seasonal migrations, but instead make short-range seasonal movements in spring and fall (Falcone et al., 2011; Falcone & Schorr, 2011). Six tags were deployed on fin whales in the Southern California portion of the HSTT Study Area in August 2014 (Mate et al., 2015a). The movements of these whales were highly variable ranging from less than 1 km to approximately 232 km from the California coast, a core area generally north of the Southern California portion of HSTT Study Area, and moving as far north as the Oregon border with California and as far south as Central Baja Mexico (Mate et al., 2015a). Off the U.S. west coast, fin whales typically congregate in areas of high productivity. Fin whales are not known to have a specific habitat and are highly adaptable, following prey, typically off the continental shelf (Azzellino et al., 2008; Panigada et al., 2008).

Based on predictive habitat-based density models derived from line-transect survey data collected between 1991 and 2009 off the U.S. west coast, relatively high densities of fin whales are predicted off southern California during the summer and fall (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012a; Becker et al., 2016; Forney et al., 2012). Aggregations of fin whales are present year-round in southern and central California (Campbell et al., 2015; Douglas et al., 2014b; Forney et al., 1995; Forney & Barlow, 1998; Jefferson et al., 2014), although their distribution shows seasonal shifts. Sightings from year-round surveys off southern California from 2004 to 2013 show fin whales farther offshore in summer and fall and closer to shore in winter and spring (Campbell et al., 2014; Douglas et al., 2014b).

As was done for other species, a scientific review process (Ferguson et al., 2015b) was undertaken to identify biologically important areas for fin whales occurring along the U.S. west coast. Survey data indicates that fin whale distributions shift both seasonally as well as annually (Calambokidis et al., 2015a; Douglas et al., 2014b; Jefferson et al., 2014). Using available quantitative density and distribution mapping, the best available science, and expert elicitation, definitive areas of importance for fin whales could not be determined(Calambokidis et al., 2015a).

(Scales et al., 2017) suggested the possibility of year-round fin whale presence in Southern California based on habitat suitability modeling and medium-term satellite tag tracking. Several core areas were proposed based on habitat modeling with many of the highest use areas north of the HSTT SOCAL study area.

4.1.3.3 Population Trends

For Hawaii, no data are available on current population trends for fin whales (Carretta et al., 2015).

For California, Moore and Barlow (2011) predict continued increases in fin whale numbers over the next decade, and suggest that fin whale densities are reaching "current ecosystem limits." Based on a comparison of sighting records from the 1950s to 2012, Smultea and Jefferson (2014) also showed an increase in the relative abundance of fin whales inhabiting the Southern California portion of the HSTT Study Area. Širović et al. (2015) used passive acoustic monitoring of fin whale calls to estimate the spatial and seasonal distribution of fin whales in the Southern California Bight. An increase in the number of calls detected between 2006 and 2012 also suggests that the population of fin whales off the U.S. west coast may be increasing. Based on 18 aerial surveys conducted between 2008 and 2013, fin whales were one of the most common large whales in the Southern California portion of the HSTT Study Area (Jefferson et al., 2014). These findings and the trend for an increase in population appear consistent with the highest-yet abundances of fin whales in the most recent 2014 survey (Barlow, 2016).

4.1.4 GRAY WHALE (*ESCHRICHTIUS ROBUSTUS*)

4.1.4.1 Status and Management

There are two north Pacific populations of gray whales: the Western subpopulation and the Eastern subpopulation (Weller et al., 2013). Both populations (stocks) could be present in the Southern California portion of the Study Area during their northward and southward migration (Mate et al., 2015b; Sumich & Show, 2011a). The Western subpopulation, which was previously also known as the western north Pacific or the Korean-Okhotsk population, has been designated the Western North Pacific stock (Carretta et al., 2017; Cooke et al., 2015; Weller et al., 2002). This stock is critically endangered, shows no apparent signs of recovery, and should be very rare in the Southern California portion of the HSTT Study Area given they are so few in number. The Eastern North Pacific stock (also known as the

eastern north Pacific or the California-Chukchi population) has recovered from whaling exploitation and was removed from listing under the ESA in 1994 (Swartz et al., 2006).

4.1.4.2 Habitat and Geographic Range

Gray whales are not present in the Hawaii portion of the HSTT Study Area.

Gray whales of the Western North Pacific stock primarily occur in shallow waters over the U.S. west coast, Russian, and Asian continental shelfs and are considered to be one of the most coastal of the great whales (Jefferson et al., 2015; Jones & Swartz, 2009). Feeding grounds are generally less than 225 ft. deep (Jones & Swartz, 2009).

Some gray whales make the longest annual migration of any mammal, 15,000–20,000 km roundtrip (Jones & Swartz, 2009; Mate et al., 2013; Mate et al., 2015b; Weller et al., 2012b; Weller et al., 2013). The migration routes of the Western North Pacific stock of gray whales had previously been poorly known and sighting data suggested that the western gray whale population had a limited range extent between the Okhotsk Sea off the coast of Sakhalin Island and the South China Sea (Weller et al., 2002). However, subsequent long-term studies of radio-tracked whales, improved photographic identification, and genetic studies have since indicated that the coastal waters of eastern Russia, the Korean Peninsula, and Japan are part of the Western North Pacific stock's western Pacific migration route while other "Sakhalin" whales have been detected along the North American coast from British Columbia, Canada, and as far south as Baja California, Mexico (Mate et al., 2015b; Muir et al., 2016; Weller et al., 2002; Weller et al., 2012a; Weller et al., 2012b; Weller et al., 2013). NMFS has previously determined that 18 western gray whales have been identified in waters far enough south to have passed through the HSTT Study Area (National Marine Fisheries Service, 2014b).

Gray whales migrate between October and July (Calambokidis et al 2015a) and are only present in the Southern California portion of the HSTT Study Area while migrating through those waters. A year-long (2013–2014) survey effort in the nearshore waters off San Diego within the HSTT Study Area encountered gray whales in January, February, and in the April–June timeframe (Graham & Saunders, 2015). For purposes of the analysis, Navy has assumed that a very small percentage of migrating gray whales could be individuals from the endangered Western North Pacific stock. The timing of the October–July gray whale migrations that pass through the Southern California portion of the HSTT Study Area can be loosely categorized into three phases (Calambokidis et al., 2015b; Jones & Swartz, 2009; Mate et al., 2013; Mate & Urban-Ramirez, 2003; Mate et al., 2015b; Rugh et al., 2008; Rugh et al., 2005). Calambokidis et al. (2015b) note these migration phases are not distinct, the timing for a phase may vary based on environmental variables, and that a migration phase typically begins with a rapid increase in migrating whales, followed by moderate numbers over a period of weeks, and then slowly tapering off.

A southward migration from summer feeding areas off Sakhalin Island, in the Chukchi Sea, Bering Sea, Gulf of Alaska, and the Pacific Northwest begins in the fall (Calambokidis et al., 2015b; Mate et al., 2013; Mate et al., 2015b). This Southbound Phase includes all age classes as they migrate primarily to the nearshore waters and lagoons of Baja California, Mexico as a destination. During this southward migration from October through March, the whales generally are within 10 km of the coast (Calambokidis et al., 2015b) although there are documented exceptions where migrating gray whales have bypassed the coast by crossing sections of the open ocean (Mate & Urban-Ramirez, 2003; Mate et al., 2015b). In the Southern California portion of the HSTT Study Area, migrating gray whales may

deviate farther from the mainland as some are routinely seen near the Channel Islands and to the west of San Clemente Island (Sumich & Show, 2011a).

Consistent with the determinations made for the identification of the Biologically Important Area migration corridor phases, the Navy assumed the northward migration to the northern feeding grounds (off Sakhalin Island for the Western North Pacific Stock) occurs in two phases just as has been determined for the Eastern North Pacific stock (Calambokidis et al., 2015b). As described for the U.S. west coast, the Northbound Phase A consists mainly of adults and juveniles that lead the beginning of the north-bound migration from late January through July, peaking in April through July. Northbound Phase A whales generally stay within 8 km of the coast (Calambokidis et al., 2015b). Newly pregnant females go first to maximize feeding time, followed by adult females and males, then juveniles (Jones & Swartz, 2009). The Northbound Phase B consists primarily of cow-calf pairs which begin their northward migration later (February to July) remaining on the reproductive grounds longer to allow calves to strengthen and rapidly increase in size before the northward migration (Jones & Swartz, 2009; Mate et al., 2010). Northbound Phase B gray whales with calves migrate closer to the coast than adults and juveniles, staying generally within 5 km of the coast (Calambokidis et al., 2015b). Because some gray whales may take migration paths farther offshore, an additional potential presence migration corridor has been identified along the coast of North America out to 47 km from the coastline (Calambokidis et al., 2015b).

The gray whale migration corridor, the potential presence migration buffer, and the months they are cumulatively in use (October through July) were identified by Calambokidis et al. (2015a) as areas that should be considered given the potential for human activities to impact this important seasonal migration behavior. While the identified migration areas have a southern boundary ending at the border with Mexico, Navy recognizes that gray migration routes extend beyond the currently identified areas and continue on outside of the U.S. Exclusive Economic Zone (see Aquatic Mammals (2015); Ferguson et al. (2015a); Van Parijs et al. (2015)) regarding the limits to the areas identified).

Unlike the remainder of the U.S. west coast where phases of migration occur within specific distances from the shore, in waters south of Point Conception in the Southern California Bight the entire migration corridor, whichincludes waters to the west of the Channel Islands, is used during each migration phase (Calambokidis et al., 2015a). The following bullets provide the applicable season for the gray whale migration corridor and potential presence area (as detailed in Calambokidis et al. (2015b)) within the Southern California portion of the HSTT Study Area:

- Southbound – October–March
- Northbound Phase A – January–July; peaking April–July
- Northbound Phase B – March–July
- Potential presence – October–July

Based on the identified migratory seasons, gray whales should only be absent from the Southern California portion of the HSTT Study Area in the August–September timeframe (Calambokidis et al., 2015a). The National Oceanic and Atmospheric Administration's website containing data records for marine mammals from the Cetacean Density and Distribution Mapping Working Group (see Ferguson et al. (2015a)) shows the recorded presence of gray whales in the Southern California Bight in every month of the year except June, October and November. As a result of the Cetacean Density and Distribution Mapping Working Group records and area specific surveys, Navy assumes that gray whales could be

migrating through the Southern California portion of the HSTT Study Area between the months of December through September; 10 months of the year.

Gray whales are generally slow-moving animals (Jefferson et al., 2015). Migrating gray whales sometimes exhibit a unique "snorkeling" behavior, whereby they surface cautiously, exposing only the area around the blowhole, exhale quietly without a visible blow, and sink silently beneath the surface (Jones & Swartz, 2009). Mate and Urban-Ramirez (2003) reported an average gray whale speed of approximately 5.2 km per hour (km/hr.) based on a tagged migrating animal. Subsequent satellite tag data from seven additional gray whales provided by Mate et al. (2015b) showed migration swim speeds ranged from 0.6 km/hr. to 6.6 km/hr., which remains within the average previously suggested. At this average swim speed, and based on the three main migration routes presented in Sumich and Show (2011b), it should take approximately 24–36 hours for a gray whale to cross through the Southern California portion of the HSTT Study Area (a distance of approximately 130–250 km). It is assumed they will do this transit across the HSTT Study Area twice a year during their annual southbound and northbound migration legs.

4.1.4.3 Population Trends

The Western North Pacific subpopulation of gray whale was once considered extinct but now small numbers are known to exist (Carretta et al., 2017; Cooke et al., 2015; International Union for Conservation of Nature, 2012; International Whaling Commission, 2014; Mate et al., 2015b; Weller et al., 2013). There are no current population trend data available at this time (Carretta et al., 2017), however, previous data on population growth indicated a positive growth of roughly 2.5 to 3.2 percent per year for the Western North Pacific stock (National Marine Fisheries Service, 2014b). As noted previously, 18 western gray whales have been identified in waters far enough south to have passed through the HSTT Study Area (National Marine Fisheries Service, 2014b).

4.1.5 HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)

4.1.5.1 Status and Management

Humpback whales that are seasonally present in the HSTT Study Area are from two stocks and three Distinct Population Segments. In the North Pacific Ocean and under the MMPA, the stock structure of humpback whales is defined by NMFS based on the species' fidelity to feeding grounds (Bettridge et al., 2015a; Muto et al., 2017; National Marine Fisheries Service, 2016b).

For humpback whales present in Hawaii in the winter and spring, NMFS has designated those animals as being part of the Central North Pacific stock given they migrate in the summer and early fall to feed in northern British Columbia and Alaska, the Gulf of Alaska, the Bering Sea, and Aleutian Islands (Muto et al., 2017). As implied by the name, the Central North Pacific stock includes animals that winter in many locations other than Hawaii including, for example, humpback whales from Japan and Mexico (Calambokidis et al., 2008; Wade et al., 2016a). The subset of animals from the Central North Pacific stock that winter in Hawaii have been designated the Hawaii Distinct Population Segment pursuant to the ESA (Bettridge et al., 2015a; Carretta et al., 2017; Muto et al., 2017; National Marine Fisheries Service, 2016b; Wade et al., 2016a). These humpback whales belonging to the Hawaii Distinct Population Segment are not listed as either threatened or endangered under the ESA given that the population in Hawaii is believed to have fully recovered and have an abundance greater than the pre-whaling estimated population (Barlow et al., 2011; Bettridge et al., 2015a; Muto et al., 2017; National

Marine Fisheries Service, 2016b; Wade et al., 2016a). The Hawaiian Islands Humpback Whale National Marine Sanctuary is located within the Hawaii Range Complex portion of the HSTT Study Area.

For humpback whales present in the Southern California portion of the HSTT Study Area, NMFS has designated those animals as being part of the California, Oregon, and Washington stock. The subset of animals from the California, Oregon, and Washington stock that are present in the Southern California portion of the HSTT Study Area are from the Mexico Distinct Population Segment and the Central America Distinct Population Segment (Bettridge et al., 2015b; Carretta et al., 2017; Muto et al., 2017; National Marine Fisheries Service, 2016a; Wade et al., 2016b). Humpback whales of the Mexico Distinct Population Segment are listed as threatened and those from the Central America Distinct Population Segment are listed as endangered under the ESA (National Marine Fisheries Service, 2016b). Breeding and calving areas for the Mexico Distinct Population Segment in Mexican waters and for the Central America Distinct Population Segment off Central America are both located far to the south of the Southern California portion of the HSTT Study Area.

4.1.5.2 Habitat and Geographic Range

The habitat requirements of wintering humpbacks appear to be controlled by the conditions necessary for calving, such as warm water (75 to 80° Fahrenheit [24° to 28° Celsius]) and relatively shallow, low-relief ocean bottom in protected areas, nearshore or created by islands or reefs (Clapham, 2000; Craig & Herman, 2000; Smultea, 1994). In breeding grounds, females with calves occur in significantly shallower waters than other groups of whales, and breeding adults use deeper more offshore waters (Ersts & Rosenbaum, 2003; Smultea, 1994). Breeding and calving areas for the Mexico Distinct Population Segment in Mexican waters and for the Central America Distinct Population Segment off Central America are both located far to the south of the Southern California portion of the HSTT Study Area.

Humpback whales are distributed worldwide in all major oceans and most seas (Bettridge et al., 2015a; National Marine Fisheries Service, 2016b). They typically are found during the summer in high-latitude feeding grounds, including Alaska and British Colombia, and during the winter migrate to area such as Hawaii, Mexico, Central America, and Okinawa where breeding and calving occurs. As a result, humpback migrations are complex and cover long distances (Bettridge et al., 2015a; Calambokidis et al., 2008; Calambokidis et al., 2009b; Mate et al., 1997). Satellite tagging of humpback whales off Kauai found that one adult traveled 155 NM to Oahu, Hawaii in 4 days, while a different individual traveled to Penguin Bank and the Kalohi Channel between Molokai and Lanai, totaling 530 NM in 10 days (Mate et al., 1997). Three additional whales returning north to summer feeding grounds traveled independent courses to the north and northeast enroute to the Gulf of Alaska, with the fastest averaging 93 NM per day. At this rate, the animal would take an estimated 39 days to travel the entire 2,600 NM migration route to the upper Gulf of Alaska from Hawaii (Mate et al., 1997).

Humpback whales that breed in Hawaii generally migrate to northern British Columbia and southeast Alaska to feed (Bettridge et al., 2015a; Calambokidis et al., 2008). Animals breeding in Hawaii have also been "matched" (i.e., identified as the same individual using photo-identification methods) to humpbacks feeding in the Gulf of Alaska, the Aleutian Islands, and Bering Sea (Calambokidis et al., 2008). In all these feeding areas, humpback whales from Hawaii must cross paths with humpback whales migrating from Mexico and Central America. In addition, based on the identification of individual whales, there is evidence that some humpback whales (most likely males) move between winter breeding areas in Hawaii and Mexico (Forestall and Urban-Ramirez 2007) and Hawaii and Japan (Salden et al. 1999).

In the Hawaii portion of their range, peak densities are from February through March, although the breeding season typically spans December through April (Baird et al., 2015c; Mobley et al., 1999; Mobley et al., 2001b; Norris et al., 1999). Acoustic recordings near the northwestern Hawaiian Islands indicate that humpback whales were present in that portion of the HSTT Study Area from early December through early June (Lammers et al. 2011). It is not yet known if this represents a previously undocumented breeding stock or if the whales occurring at the northwestern Hawaiian Islands are part of the same population that winters near the Main Hawaiian Islands (Bettridge et al., 2015a). Acoustic recordings over multiple years (including 2016) using the Pacific Missile Range Facility hydrophones have demonstrated a seasonal presence of humpback whales off Kauai from November to May (Martin et al., 2016; Martin et al., 2017).

For the Hawaii Distinct Population Segment of humpback whales present in Hawaii during the breeding season, the majority of humpback whales have been detected within the 200 m isobath constituting shallow water (Mobley et al., 2001b; Mobley, 2005; Mobley & Pacini, 2013; Mobley et al., 2015). This presence may include very nearshore and inland water areas (Richie et al., 2016).

The greatest densities of humpback whales (including calves) have been in the four-island region consisting of Maui, Molokai, Kahoolawe, and Lanai, as well as Penguin Bank (Mobley et al., 2001b) and around Kauai (Mobley, 2005). A March 2007 pilot survey across the Northwest Hawaiian Islands documented the existence of extensive wintering habitat used by humpback whales in the Northwest Hawaiian Islands (Johnston et al., 2007).

From December 2013 to January 2014, a passive acoustic recording device onboard an unmanned glider moving in the deep ocean approximately 100 to 300 km south of Oahu recorded humpback whale songs during all recording periods (Klinck et al., 2015). While the acoustic data does not provide an indication for how far away the animals are from the recorder, they would have definitely been offshore as opposed to nearshore shallow water areas previously documented as their preferred habitat. Humpback whales migrating from breeding grounds in Hawaii to feeding grounds at higher latitudes may cross eastern portions of the HSTT Study Area Transit Corridor.

There have been six locations identified in the main Hawaiian Islands as a single reproductive area for humpback whales (Baird et al. 2015).

Off the U.S. west coast, humpback whales are more abundant in shelf and slope waters (<2,000 m deep), and are often associated with areas of high productivity (Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012; Redfern et al., 2013). While most humpback whale sightings are in nearshore and continental shelf waters, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al., 2001; Clapham & Mattila, 1990; Clapham, 2000; Mate et al., 1997). Humpback whales migrating from breeding grounds in Central America to feeding grounds at higher latitudes may cross the Southern California portion of the HSTT Study Area including the Transit Corridor located farther offshore. While most humpback whales migrate, data from surveys conducted between 2004 and 2013 show that humpback whales occur year-round off southern California (Campbell et al., 2015). Peak occurrence during migration occurs in the Southern California portion of the Study Area from December through June (Calambokidis et al., 2015a). During late summer, more humpback whales are sighted north of the Channel Islands, and limited occurrence is expected south of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz) (Carretta et al., 2010). Based on aerial survey data collected between 2008 and 2012 in the Southern California portion of the HSTT Study Area, Smultea and Jefferson (2014) determined that humpback whales ranked eighth in relative occurrence

and concluded that this species has clearly increased their representation in the Navy's Southern California range complex over the last several decades.

The wintering areas for the Mexico Distinct Population Segment are the waters and islands off Mexico and, for the Central America Distinct Population Segment, the wintering areas are waters from southern Mexico and south along the coast of Central America (Calambokidis et al., 2008). There have been no identified biologically important areas for humpback whales in the Southern California portion of the HSTT Study Area (Calambokidis et al., 2015a).

4.1.5.3 Population Trends

Even with routine training and testing overlapping the areas where humpbacks occur in Hawaii, the population of humpback whales in the Hawaiian Islands has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al., 2011; Wade et al., 2016a). Data indicates the north Pacific population has been increasing at a rate of between 5.5 percent and 6.0 percent per year, approximately doubling every 10 years (Bettridge et al., 2015a; Muto et al., 2017; Wade et al., 2016a).

Although recent estimates show variable trends in the number of humpback whales along the U.S. west coast, the overall trend in the estimates is consistent with a growth rate of 6 to 7 percent for the California, Oregon, and Washington stock and appear consistent with the highest-yet abundances of humpback whales in the most recent 2014 survey of that stock (Barlow, 2016; Carretta et al., 2017; Smultea & Jefferson, 2014). For the distinct population segments in Mexico and Central America, photo-identification data collected between 2004 to 2006 are the main basis for the most recent estimates of humpback whale numbers in those breeding locations in the Pacific (Bettridge et al., 2015a; National Marine Fisheries Service, 2016b; Wade et al., 2016a). There are no population trend data for the Mexico Distinct Population Segment or the Central America Distinct Population Segment since there have been no subsequent data collected for comparison (Bettridge et al., 2015a; National Marine Fisheries Service, 2016b; Wade et al., 2016a).

4.1.6 MINKE WHALE (*BALAENOPTERA ACUTOROSTRATA*)

4.1.6.1 Status and Management

The minke whale is protected under the MMPA and is not listed under the ESA. Minke whales in Hawaii are designated the Hawaiian stock and those in the Southern California portion of HSTT are part of the California, Oregon, and Washington stock (Carretta et al. 2016).

4.1.6.2 Habitat and Geographic Range

The minke whale's range is known to include the open ocean, coastal waters, and extends from subarctic to arctic waters (Kuker et al., 2005). Minke whales previously were considered a rare species in Hawaiian waters due to limited sightings and detections, seeming to only be present around the Hawaiian Islands in the October to April timeframe (Barlow, 2006; Carretta et al., 2017; Klinck et al., 2015; Lammers et al., 2015). The first documented sighting of a minke whale close to the main Hawaiian islands was made off the southwest coast of Kauai in 2005 (Norris et al., 2005; Rankin et al., 2007) and there have been only two other confirmed sightings within 200 NM of the Hawaiian Island (Bradford et al., 2013). Research involving passive acoustic detection suggests minke whales are somewhat common in Hawaii in the winter (Klinck et al., 2015; Rankin & Barlow, 2005; Rankin et al., 2007; U.S. Department of the Navy, 2011b). Acoustic recordings over multiple years (including 2016) using the Pacific Missile

Range Facility hydrophones have demonstrated a seasonal presence of minke whales off Kauai from November to May (Martin et al., 2017).

During a 2002 survey around the Hawaiian Islands, minke whales were confirmed as the source of the mysterious "boing" sound of the north Pacific Ocean, specifically offshore of Kauai and closer in, near the Pacific Missile Range Facility, Barking Sands region (Barlow et al., 2004; Rankin & Barlow, 2005). This information subsequently allowed for acoustic detections of minke whales, although they remain rarely observed during visual surveys and its now widely accepted that their cryptic surfacing behavior is the reason for the low sighting rates (Barlow, 2006; Bradford et al., 2013; Bradford et al., 2017; Lammers et al., 2015; Rankin et al., 2007). Research using a survey vessel's towed acoustic array and the Navy's hydrophones off Kauai in 2009-2010 (35 days total) provided bearings to 1,975 minke whale "boing" vocalizations located within the instrumented range offshore of the Pacific Missile Range Facility (U.S. Department of the Navy, 2011d); this is an area where training and testing has routinely occurred for decades. Subsequent research using the range hydrophones to count and localize vocalizations provided an estimated average density of 3.2 whales/3,780 square kilometers (Martin et al., 2015a). This was a minimum density since it was assumed that only mature male minkes were vocalizing and being localized, and individuals capable of calling may have been silent.

Minke whales occur year-round off California (Forney et al., 1995; Forney & Barlow, 1998), mainly in nearshore areas (Barlow & Forney, 2007; Hamilton et al., 2009; Smultea & Jefferson, 2014). During systematic ship surveys conducted in summer and fall off the U.S. west coast between 1991 and 2014, there were 28 minke whale sightings (Barlow, 2016). During year-round aerial surveys conducted in the Southern California Range Complex from 2008 through 2013, minke whales were sighted 19 times (Jefferson et al., 2014).

The migration paths of the minke whale include travel between breeding to feeding grounds and have been shown to follow patterns of prey availability (Jefferson et al., 2015). Minke whales generally participate in annual migrations between low-latitude breeding grounds in the winter and high-latitude feeding grounds in the summer (Kuker et al., 2005). This may explain their seasonal acoustic presence in Hawaii. There is insufficient information to determine if the year-round low numbers of minke whales detected in Southern California suggests there may be resident animals although acoustic monitoring data indicating only occasional minke boing presence in spring and late fall (Debich et al., 2015a; Hildebrand et al., 2012) would be consistent with a general seasonal migration pattern.

4.1.6.3 Population Trends

There are no data on trends for minke whales in the Hawaiian stock or the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.7 SEI WHALE (*BALAENOPTERA BOREALIS*)

4.1.7.1 Status and Management

The sei whale is listed as endangered under the ESA and as depleted under the MMPA, but there is no designated critical habitat for this species. A recovery plan for the sei whale was completed in 2011 and provides a research strategy for obtaining data required to estimate population abundance and trends, and to identify factors that may be limiting the recovery of this species (National Marine Fisheries Service, 2011b). Sei whales in Hawaii are assigned to the Hawaii stock. Along the U.S. west coast, the

Eastern North Pacific stock is recognized within the U.S. Exclusive Economic Zone including the Southern California portion of the HSTT Study Area (Carretta et al., 2017).

4.1.7.2 Habitat and Geographic Range

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. During the winter, sei whales are found in warm tropical waters like Hawaii. Sei whales are also encountered during the summer off California and the North America coast from approximately the latitude of the Mexican border to as far north as Vancouver Island Canada (Horwood, 2009; Masaki, 1976, 1977; Smultea et al., 2010). Although sei whales have been observed south of 20° N in the winter (Fulling et al., 2011; Horwood, 2009; Horwood, 1987), they are considered absent or at very low densities in most equatorial areas. Whaling data provide some evidence of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males (Horwood, 1987; Perry et al., 1999).

Sei whales have only been detected in the Hawaiian Islands on a few occasions. Sei whales were not sighted during aerial surveys conducted within 25 NM of the main Hawaiian Islands from 1993 to 1998 (Mobley et al., 2000). The first verified sei whale sighting made nearshore of the main Hawaiian Islands occurred in 2007 (Smultea et al., 2007; Smultea et al., 2010) and included the first subadults seen in the main Hawaiian islands. The presence of these subadults was cited as evidence suggesting that the area north of the main Hawaiian Islands may be part of a reproductive area for north Pacific sei whales (Smultea et al., 2010). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the sighting of three Bryde's/sei whales. An additional sighting occurred in 2010 off Perret Seamount (U.S. Department of the Navy, 2011d). On March 18, 2011 off Maui, the Hawaiian Islands Entanglement Response Network found a subadult sei whale entangled in rope and fishing gear (Bradford & Lyman, 2015; National Marine Fisheries Service, 2011a). An attempt to disentangle the whale was unsuccessful although a telemetry buoy attached to the entangled gear was reported to be tracking the whale over 21 days as it moved north and over 250 NM from the Hawaiian Islands. In December 2014, a passive acoustic recording device onboard an unmanned glider located to the south of Oahu detected very short, low-frequency downsweep vocalizations identified as potential sei whale calls and occurring occasionally during a period of approximately 2 weeks (Klinck et al., 2015).

Sei whales are distributed in offshore waters in the Southern California portion of the HSTT Study Area (Carretta et al., 2017). A total of 10 sei whale sightings were made during systematic ship surveys conducted off the U.S. west coast in summer and fall between 1991 and 2008 (Barlow, 2010), with an additional 14 groups sighted during a 2014 survey (Barlow, 2016). Sei whales were not seen in the Southern California portion of the HSTT Study Area (or the larger Southern California Bight) during 15 aerial surveys conducted from 2008 through 2012 (Smultea et al., 2014) or during any systematic ship surveys conducted by NMFS (Barlow, 2010, 2016).

Sei whales are likely present in the Transit Corridor portion of the Study Area, and are seen at least as far south as 20° N into the North Pacific Gyre (Horwood, 2009; Horwood, 1987).

4.1.7.3 Population Trends

No data are available on current population trends for either stock of sei whales in the HSTT Study Area (Carretta et al., 2017).

4.1.8 SPERM WHALE (*PHYSETER MACROCEPHALUS*)

4.1.8.1 Status and Management

The sperm whale has been listed as endangered since 1970 under the precursor to the ESA (National Marine Fisheries Service, 2009a), and is depleted under the MMPA, but there is no designated critical habitat for this species in the North Pacific. Sperm whales are divided into three stocks in the Pacific; two (Hawaii and California/Oregon/Washington) occur within the Study Area. Based on genetic analyses, Mesnick et al. (2011) found that sperm whales in the California Current are demographically independent from animals in Hawaii and the eastern tropical Pacific.

4.1.8.2 Habitat and Geographic Range

The sperm whale's range occurs throughout the entire Study Area. Primarily, this species is typically found in the temperate and tropical waters of the Pacific (Rice, 1989). The secondary range includes the areas of higher latitudes in the northern part of the Study Area (Jefferson et al., 2015; Whitehead & Weilgart, 2000; Whitehead et al., 2008; Whitehead, 2009). This species appears to have a preference for deep waters (Baird et al., 2013d; Jefferson et al., 2015). Typically, sperm whale concentrations correlate with areas of high productivity. These areas are generally near drop offs and areas with strong currents and steep topography (Gannier & Praca, 2007; Jefferson et al., 2015).

Sperm whales occur in Hawaii waters year-round and are one of the more abundant large whales found in that region (Baird et al., 2003b; Barlow, 2006; Bradford et al., 2017; Mobley et al., 2000). A total of 21 sperm whale sightings were made during a summer/fall 2002 shipboard survey of waters within the U.S. Exclusive Economic Zone of the Hawaiian Islands, although only four of these sightings were around the Main Hawaiian Islands (Barlow, 2006). During a follow-up survey conducted in 2010, there were 41 sperm whale sightings, mainly concentrated in the northwestern portion of the U.S. Exclusive Economic Zone of the Hawaiian Islands (Bradford et al., 2017). Based on predictive habitat-based density models derived from line-transect survey data collected between 1997 and 2012 within the central North Pacific, relatively high densities of sperm whales are predicted within the U.S. Exclusive Economic Zone of the Hawaiian Islands during the summer and fall, particularly in the northwest (Forney et al., 2015). In 2015, acoustic detections of sperm whales occurred over the abyssal plain to the south of Oahu and did not seem to be related to bathymetric features such as seamounts (Klinck et al., 2015).

Sperm whales are found year-round in California waters, but their abundance is temporally variable, most likely due to the availability of prey species (Barlow, 1995; Barlow & Forney, 2007; Forney & Barlow, 1993; Smultea & Jefferson, 2014). Based on habitat models derived from line-transect survey data collected between 1991 and 2008 off the U.S. west coast, sperm whales show an apparent preference for deep waters (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012a; Forney et al., 2012). During quarterly ship surveys conducted off southern California between 2004 and 2008, there were a total of 20 sperm whale sightings, the majority (12) occurring in summer in waters greater than 2,000 meters deep (Douglas et al., 2014b). Only one sperm whale group was observed during 18 aerial surveys conducted in the Southern California Bight from 2008 through 2012 (Smultea et al., 2014). Their distribution is typically associated with waters over the continental shelf break, over the continental slope, and into deeper waters (Carretta et al., 2017; Rice, 1989; Whitehead, 2003; Whitehead et al., 2008).

Sperm whales are somewhat migratory. General shifts occur during summer months for feeding and breeding, while in some tropical areas, sperm whales appear to be largely resident (Rice, 1989;

Whitehead, 2003; Whitehead et al., 2008; Whitehead, 2009). Pods of females with calves remain on breeding grounds throughout the year, between 40° N and 45° N (Rice, 1989; Whitehead, 2003), while males migrate between low-latitude breeding areas and higher-latitude feeding grounds (Pierce et al., 2007). In the northern hemisphere, "bachelor" groups (males typically 15 to 21 years old and bulls [males] not taking part in reproduction) generally leave warm waters at the beginning of summer and migrate to feeding grounds that may extend as far north as the perimeter of the arctic zone. In fall and winter, most return south, although some may remain in the colder northern waters during most of the year (Pierce et al., 2007).

4.1.8.3 Population Trends

Moore and Barlow (2014) used a Bayesian hierarchical approach to examine sperm whale population abundance and trends based on line-transect surveys conducted off the U.S. west coast from 1991 to 2008. Although an estimate of trends was not conclusive, they found that the abundance of adult male sperm whales has increased (Moore & Barlow, 2014). Moore and Barlow (2017) updated their sperm whale assement using new data from a NMFS 2014 U.S. west coast survey. While they reported little evidence of increasing trends in overall sperm whale abundance, the new analysis supports prior evidence for an increasing number of sperm whales that occur in small groups (presumed to be adult or near-adult males.

4.1.9 PYGMY SPERM WHALE (*KOGIA BREVICEPS*)

There are two species of *Kogia*: the pygmy sperm whale (*Kogia breviceps*) and the dwarf sperm whale (*Kogia sima*; discussed in Section 4.1.10, Dwarf Sperm Whale [*Kogia sima*]). Dwarf and pygmy sperm whales are difficult to detect and distinguish from one another at sea, and many misidentifications have been made. Sightings of either species are often categorized as the genus *Kogia* (Jefferson et al., 2015).

4.1.9.1 Status and Management

The pygmy sperm whale is protected under the MMPA but is not listed under the ESA. Pygmy sperm whales are divided into two discrete stocks: (1) the Hawaiian stock and (2) the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.9.2 Habitat and Geographic Range

The pygmy sperm whale frequents more temperate habitats than the dwarf sperm whale, which is more of a tropical species.

Sightings of pygmy sperm whales are rarely reported in Hawaii (Baird et al., 2013d; Oleson et al., 2013). During boat surveys between 2000 and 2012 in the main Hawaiian Islands, this species was observed, but less commonly than the dwarf sperm whale (Baird et al., 2003b; Baird, 2005; Baird et al., 2013d; Barlow et al., 2004; Oleson et al., 2013). Pygmy sperm whales are one of the more commonly stranded species in the Hawaiian Islands, and this frequency of strandings indicates that the species is likely more common than sightings suggest (Maldini et al., 2005).

Pygmy sperm whales have only rarely been sighted along the U.S. west coast during surveys and the limited sightings cannot be used to produce a reliable population estimate (Carretta et al., 2017). Several studies have suggested that this species generally occurs beyond the continental shelf edge (Bloodworth & Odell, 2008; MacLeod et al., 2004) and all confirmed pygmy sperm whale sightings off the U.S. west coast have been well offshore (Barlow, 2016; Hamilton et al., 2009). For California, a total

of six pygmy sperm whale sightings have been made in offshore waters along the U.S. west coast during systematic surveys conducted between 1991 and 2014 (Barlow, 2016; Hamilton et al., 2009). There were no *Kogia* detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014).

Movement patterns for this species are poorly understood. No specific information regarding routes, seasons, or resighting rates in specific areas is available for the HSTT Study Area.

4.1.9.3 Population Trends

There are no data available for an analysis of population trend for pygmy sperm whales in the Pacific (Carretta et al., 2017).

4.1.10 Dwarf Sperm Whale (*Kogia sima*)

There are two species of *Kogia*: the pygmy sperm whale (discussed in Section 4.1.9, Pygmy Sperm Whale [*Kogia breviceps*]) and the dwarf sperm whale, which had previously been considered to be the same species. Dwarf and pygmy sperm whales are difficult to distinguish from one another at sea, and many misidentifications have been made. Sightings of either species are often categorized as the genus *Kogia* (Jefferson et al., 2015).

4.1.10.1 Status and Management

The dwarf sperm whale is protected under the MMPA and is not listed under the ESA. Dwarf sperm whales within the Pacific U.S. Exclusive Economic Zone are divided into two separate stocks: (1) the Hawaiian stock and (2) the California, Oregon, and Washington stock (Carretta et al. 2016).

4.1.10.2 Habitat and Geographic Range

Dwarf sperm whales tend to occur over the outer continental shelf, and they may be relatively coastal in some areas with deep waters nearshore (MacLeod et al., 2004). Although the dwarf sperm whale appears to prefer more tropical waters than the pygmy sperm whale, the exact habitat preferences of the species are not well understood. Records of this species from both the western Pacific (Taiwan) and eastern Pacific (California) suggest that its range includes the waters off Southern California and Hawaii (Carretta et al., 2017; Jefferson et al., 2008; Wang et al., 2001; Wang & Yang, 2006).

During the 2002 NMFS survey of the Hawaiian Islands there were five dwarf sperm whale sightings and one sighting in the 2010 survey of the area (Barlow, 2006; Bradford et al., 2013; Bradford et al., 2017). During small boat surveys between 2002 and 2012 in the main Hawaiian Islands, this species was the fifth most frequently encountered species of odontocete in waters shallower than 1,000 m with a strong peak in the sighting rate where depths are between 500 and 1,000 m (Baird et al., 2013c; Oleson et al., 2013). Dwarf sperm whales have been seen near Niihau, Kauai, Oahu, Lanai, and Hawaii. Photo-identification of individuals off Hawaii Island since 2003 has provided evidence of long-term site fidelity, with a third of identified individuals being seen in more than one year, and therefore suggesting the existence of an island-resident population (Baird et al., 2015a; Oleson et al., 2013).

Along the U.S. Pacific coast, no reported sightings of this species have been confirmed as dwarf sperm whales and it is likely that most *Kogia* species off California are pygmy sperm whale (*Kogia breviceps*) (Carretta et al., 2015; Nagorsen & Stewart, 1983). There were no *Kogia* detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea et al., 2014).

This may be somewhat due to their pelagic distribution, cryptic behavior (i.e., "hidden" because they are not very active at the surface and do not have a conspicuous blow), and physical similarity to the pygmy sperm whale (Jefferson et al., 2008; McAlpine, 2009). However, the presence of dwarf sperm whales off the coast of California has been demonstrated by at least five dwarf sperm whale strandings in California between 1967 and 2000 (Carretta et al., 2010).

Although deep oceanic waters may be the primary habitat for this species, very few oceanic sightings offshore have occurred within the Study Area. The lack of sightings may be due to the difficulty of detecting and identifying these animals at sea (Jefferson et al., 2008; Maldini et al., 2005).

A year-round Small and Resident Population area has been identified for dwarf sperm whales off the west coast of the Island of Hawaii (Baird et al., 2015a). The delineated area forms a rough triangle around 55 sightings of dwarf sperm whales sighted in the area between 2002 and 2012 (Baird et al., 2015a).

4.1.10.3 Population Trends

In the Hawaiian Islands, there are no current data available for deriving a population abundance or trend (Carretta et al., 2015). Dwarf sperm whales are one of the more commonly stranded species in the Hawaiian Islands (Maldini et al., 2005), and the frequency of strandings indicates that the species is likely more common than sightings suggest (Jefferson et al., 2015). Strandings in Hawaii are relatively rare and there were four strandings of individual dwarf sperm whales in the Hawaiian Islands 5-year period between 2010 and 2015 (National Marine Fisheries Service, 2015d).

There is no information available to estimate the population size of dwarf sperm whales off the U.S. west coast. There are no known sighting records of this species despite many vessel surveys along the west coast, and sightings of unidentified *Kogia* species are likely to be pygmy sperm whales (Carretta et al., 2015).

4.1.11 Baird's Beaked Whale (*Berardius bairdii*)

4.1.11.1 Status and Management

Baird's beaked whale is protected under the MMPA and is not listed under the ESA. Baird's beaked whale stocks are defined for the two separate areas within Pacific U.S. waters where they are found: (1) Alaska and (2) California, Oregon, and Washington (Carretta et al., 2010). Baird's beaked whales have a history of commercial harvesting in small numbers by the Russians, Canadians and Americans. The Japanese fishery has historically been responsible for large numbers of deaths (Jefferson et al., 2008).

4.1.11.2 Habitat and Geographic Range

Baird's beaked whales are not present in the Hawaii portion of the HSTT Study Area.

Baird's beaked whale occurs mainly in deep waters over the continental slope, near oceanic seamounts, and areas with submarine escarpments, although they may be seen close to shore where deep water approaches the coast (Jefferson et al., 2008; Kasuya, 2009). This species is generally found throughout the colder waters of the North Pacific, ranging from off Baja California, Mexico, to the Aleutian Islands of Alaska (Jefferson et al., 2008; MacLeod & D'Amico, 2006).

The continental shelf margins from the California coast to 125° West (W) longitude were identified as key areas for beaked whales (MacLeod & D'Amico, 2006). Baird's beaked whale is found mainly north of 28° N in the eastern Pacific (Kasuya & Miyashita, 1997; Reeves et al., 2003). Along the west coast, Baird's beaked whales are seen primarily along the continental slope, from late spring to early fall (Carretta et al., 2010; Green et al., 1992; Hamilton et al., 2009). Baird's beaked whales are sighted less frequently and are presumed to be farther offshore during the colder water months of November through April (Carretta et al., 2010). Based on habitat models developed using 1991–2008 survey data collected off the west coast during summer and fall, Becker et al. (2012b) found that encounters of Baird's beaked whale increased in waters near the 2,000 m isobath. These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Forney et al., 2012). During ship surveys conducted quarterly off southern California from 2004 to 2008, there was a single sighting of a group of 20 Baird's beaked whales near the shelf break during a summer survey (Douglas et al., 2014b). Baird's beaked whales were not detected during 15 aerial surveys conducted in the SOCAL Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014).

Although it is unknown if the species migrates, Baird's beaked whales in the western north Pacific are known to move between waters of depths ranging from 1,000 to 3,000 m, where fish that live on or near the bottom of the ocean are abundant (Ohizumi et al., 2003).

4.1.11.3 Population Trends

Bayesian trend analyses indicated no trend in the abundance of Baird's beaked whales off the U.S. west coast from 1991 to 2008 (Carretta et al., 2017; Moore & Barlow, 2013). Moore and Barlow (2017) reported weak evidence of an increasing trend in Baird's beaked whales along the U.S. west coast based on a new 2014 survey.

4.1.12 Blainville's Beaked Whale (*Mesoplodon densirostris*)

4.1.12.1 Status and Management

Blainville's beaked whale is protected under the MMPA and is not listed under the ESA. In Hawaii and based on the number of sightings and genetic analysis of individuals around the Hawaiian Islands, NMFS recognizes a Hawaiian stock of Blainville's beaked whale (Carretta et al., 2015; Oleson et al., 2013). For the U.S. west coast and due to the difficulty in distinguishing different *Mesoplodon* species from one another at sea during visual surveys, the NMFS designated management unit includes all *Mesoplodon* species that occur in an area. This is the case in the Southern California portion of the HSTT Study Area where the six species of *Mesoplodon* beaked whales present along the U.S. west coast is a single stock for all *Mesoplodon* in the California/Oregon/Washington region waters, including Blainville's beaked whale (Carretta et al., 2017).

4.1.12.2 Habitat and Geographic Range

Blainville's beaked whales are one of the most widely distributed of the distinctive toothed whales within the *Mesoplodon* genus (Jefferson et al., 2008; MacLeod & Mitchell, 2006). They are found mostly offshore in deeper waters along the California coast, Hawaii, Fiji, Japan, and Taiwan, as well as throughout the eastern tropical Pacific (Leslie et al., 2005; MacLeod & Mitchell, 2006; Mead, 1989).

Blainville's beaked whales are regularly sighted in Hawaiian waters (Baird et al., 2003b; Baird et al., 2006; Baird et al., 2015b; Barlow, 2006; Bradford et al., 2017; McSweeney et al., 2007), and their vocalizations have been routinely detected in acoustic monitoring in the Hawaiian Islands (Henderson et

al., 2015; Klinck et al., 2015; Lammers et al., 2015; Manzano-Roth et al., 2016; Manzano-Roth et al., 2013; Rankin & Barlow, 2007). Blainville's beaked whale sounds were detected once at Cross Seamount during a six month acoustic monitoring in 2005-2006 (McDonald et al., 2009). In the winter of 2014 – 2015 during a three-week period (December to January), Blainville's beaked whale sounds were acoustically detected by an autonomous glider operating in an open ocean area to the south of Oahu and East of Hawaii Island (Klinck et al., 2015). These Blainville's beaked whale sounds were detected along the glider's course both in open ocean areas that lacked significant bathymetric relief and at Brigham Seamount, but not at Cross Seamount or any of the other seamounts areas sampled (Klinck et al., 2015).

Blainville's beaked whale has been detected off the coast of Oahu, Hawaii for prolonged periods annually, and this species is consistently observed in the same site off the west coast of the Island of Hawaii (Abecassis et al., 2015; Baird et al., 2006; McSweeney et al., 2007). Thirteen Blainville's beaked whales were satellite tagged off Hawaii Island between 2006 and 2012 with data records ranging from 15 to 159 days (Baird et al., 2011; Baird et al., 2015b). One tagged individual ranged from approximately 18 km to 573 km from land and moved a total of over 900 km from the initial tag location in 20 days. Similar data over an 8-day period for an individual tagged off Kauai showed movement on and off the Navy's instrument range at PMRF three times before transiting to the southwest over a distance of approximately 100 km from the original tag location (Baird et al., 2015d).

Population studies in Hawaii have demonstrated some evidence for residency (McSweeney et al., 2007). A year-round Small and Resident Population area has been identified for Blainville's beaked whales off the west coast and North Kohala portion of the Island of Hawaii (Baird et al., 2015b). The area forms a rough polygon around satellite tag locations for 10 whales in the area from 2009-2011 (Baird et al., 2015b).

There are a handful of known records of Blainville's beaked whale from the coast of California and Baja California, Mexico, but the species does not appear to be common in the Southern California portion of the Study Area (Hamilton et al., 2009; Mead, 1989; Pitman et al., 1988). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014).

4.1.12.3 Population Trends

For the Hawaiian Islands, the currently available data precludes evaluation of population trends for Blainville's beaked whales in the Hawaiian stock (Carretta et al., 2017). Acoustic monitoring using the Navy range hydrophones off Kauai from 2010 to 2014 suggest a low but stable abundance of *Mesoplodon* beaked whales at that location (Moretti, 2016).

A Bayesian trend analysis of systematic survey data collected from 1991 to 2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent study (Barlow, 2016) included data from an additional survey conducted in 2014 and indicated that the pattern seen for the U.S. west coast from 1996 to 2014 may indicate a change in that downward trend. Given that the population trend for the entire U.S. west coast is uncertain, an additional trend analysis that includes data from the recent survey may be appropriate for beaked whales in the California/Oregon/Washington stock (Barlow, 2016).

4.1.13 Cuvier's Beaked Whale (*Ziphius cavirostris*)

4.1.13.1 Status and Management

Cuvier's beaked whale is protected under the MMPA and is not listed under the ESA. Within the HSTT Study Area, Cuvier's beaked whales in Hawaii have been assigned to the Hawaiian stock and in the Southern California portion of the HSTT Study Area, animals are assigned to the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.13.2 Habitat and Geographic Range

Cuvier's beaked whales have an extensive range that includes all oceans, from the tropics to the polar waters of both hemispheres. Cuvier's beaked whales are have been encountered in almost all areas of the Pacific, including the open mid-ocean, wherever surveys have occurred (Hamilton et al., 2009). Cuvier's beaked whales are generally sighted in waters with a bottom depth greater than 200 m and are frequently recorded in waters with bottom depths greater than 1,000 m (Bradford et al., 2013; Falcone et al., 2009; Jefferson et al., 2015). Acoustic sampling of bathymetrically featureless areas off Southern California detected many beaked whales over an abyssal plain, which counters a common misperception that beaked whales are primarily found over slope waters, in deep basins, or over seamounts (Griffiths & Barlow, 2016).

Cuvier's beaked whales are regularly found in waters surrounding the Hawaiian Islands (Baird et al., 2009; Baird et al., 2013c; Baird et al., 2015c; Barlow, 2006; Baumann-Pickering et al., 2010; Baumann-Pickering et al., 2014; Bradford et al., 2013; Lammers et al., 2015; Mobley, 2004; Oleson et al., 2013; Oleson et al., 2015; Shallenberger, 1981). In Hawaii, Cuvier's beaked whales have been occasionally observed breaching and this along with their large size and visible blows likely increases their detectability (Baird et al., 2013c). During the NMFS 2010 survey of the Hawaiian Islands Exclusive Economic Zone, there were 23 sightings of Cuvier's beaked whales, which were commonly seen nearshore in the Northwestern Hawaiian Islands (Bradford et al., 2013; Oleson et al., 2013; Oleson et al., 2015). Sightings have been reported off the Hawaiian Islands of Lanai, Maui, Hawaii, Niihau, and Kauai, supporting the hypothesis that there is a resident population found in the Hawaiian Islands (Baird et al., 2009Mobley, 2004 #986; Baird et al., 2013c; Baird et al., 2015c; Oleson et al., 2013; Oleson et al., 2015; Shallenberger, 1981). Passive acoustic monitoring around in the main Hawaiian Islands has routinely recorded the presence of Cuvier's beaked whales (Baumann-Pickering et al., 2010; Lammers et al., 2015). There does not seem to be any association of Cuvier's beaked whales with the presence of seamounts in the Hawaiian Islands. Research by McDonald et al, (2009) did not detect the acoustic presence of Cuvier's beaked whales at Cross Seamount but did detect other beaked whale sounds from an as yet unidentified type or species; subsequently referred to as a BW38 FM pulse type (Baumann-Pickering et al., 2012; Baumann-Pickering et al., 2014; Baumann-Pickering et al., 2016). These absence of acoustic signals from Cuvier' beaked whales and presence of the BW38 FM pulse type were subsequently verified in the winter of 2014–2015 (December to January), for Cross Seamount and other seamounts to the south of Oahu over the three-week period of a survey (Klinck et al., 2015). Baumann-Pickering et al. (2016), have suggested a possible opposing pattern of presence, with Cuvier's beaked whales being present when acoustic encounters of BW38 FM pulse type were fewer based on passive acoustic records from a seamount to the west of the Northern Line Islands.

A year-round Small and Resident Population area has been identified for Cuvier's beaked whales surrounding Hawaii Island and including the Alenuihaha Channel across to Maui (Baird et al., 2015b).

Research involving tagged Cuvier's beaked whales in the Southern California Range Complex (Falcone et al., 2009; Falcone & Schorr, 2011, 2012, 2013, 2014) has documented movements in excess of hundreds of kilometers. Schorr et al. (2014) reported that 5 out of 8 tagged whales journeyed approximately 250 km from their tag deployment location and one of these 5 made an extra-regional excursion over 450 km to the south to Mexico and back.

Cuvier's beaked whale is the most commonly encountered beaked whale off the west coast of the United States (Carretta et al., 2017). This species is found from Alaska to Baja California, Mexico, and there are no apparent seasonal changes in distribution (Mead, 1989; Pitman et al., 1988). However, Mitchell (1968) reported that strandings from Alaska to Baja California were the most common between February and September. During ship surveys conducted quarterly off southern California from 2004 to 2008, there were only six beaked whale sightings and half of these were Cuvier's beaked whales (Douglas et al., 2014b). During 18 aerial surveys conducted in the Southern California Range Complex from 2008 through 2013, Cuvier's beaked whales were sighted on two occasions (Jefferson et al., 2014). Repeated sightings of the same individuals have been reported off San Clemente Island in Southern California, which indicates some level of site fidelity (Falcone et al., 2009; Schorr et al., 2017). This species has also frequently been heard on passive acoustic recording devices in the Southern California portion of the Study Area (Griffiths & Barlow, 2016; Širović et al., 2016). In a test of drifting passive acoustic recorders off California in the fall of 2014, Griffiths and Barlow (2016) reported beaked whale detections over slopes and seamounts, which was not unexpected, and also over deep ocean abysal plains, which was a novel finding.

4.1.13.3 Population Trends

For the Hawaiian Islands, the currently available data precludes evaluation of population trends for Cuvier's beaked whales in the Hawaiian stock (Carretta et al., 2017).

A Bayesian trend analysis of systematic survey data collected from 1991 to 2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, more recent reports (Barlow, 2016; Moore & Barlow, 2017) include data from an additional survey conducted in 2014. Their revised conclusion indicated that while Cuvier's beaked whales along the entire U.S. west coast appear to have decreased in abundance from high values in 1991-1993, that decline now appears to have leveled off. Given that the population trend for the entire U.S. west coast is uncertain, an additional trend analysis that includes data from the recent survey may be appropriate for beaked whales in the California/Oregon/Washington stock (Barlow, 2016). When considering beaked whales within the Southern California portion of the HSTT Study Area, multiple studies have indicated that for waters surrounding the Navy training and testing areas in Southern California the abundance of beaked whales remains high, including specifically where Navy has been training and testing for decades. Results from passive acoustic monitoring and other research have estimated regional Cuvier's beaked whale densities that were higher than indicated by the NMFS's broad-scale visual surveys for the U.S. west coast (Debich et al., 2015a; Debich et al., 2015b; Falcone & Schorr, 2012, 2014; Hildebrand et al., 2009; Moretti, 2016; Širović et al., 2016; Smultea & Jefferson, 2014). In a series of surveys from 2006 to 2008, Falcone et al. (2009) proposed that the ocean basin west of San Clemente Island may be an important region for Cuvier's beaked whales. While these location specific results provide no indication of a trend for the U.S. west coast, the higher abundances observed on the Navy's training and testing areas in Southern California are inconsistent with the decline noted over the remainder of the U.S. west coast from 1991 to 2008. Research also indicates higher than expected residency in the Navy's instrumented Southern California Anti-Submarine Warfare Range in

particular (Falcone & Schorr, 2012). Photo identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart (Falcone & Schorr, 2014). The documented residency by many Cuvier's beaked whales over multiple years indicate that a stable population may exist in that small portion of the stock's overall range (Falcone et al., 2009; Falcone & Schorr, 2014; Schorr et al., 2017).

4.1.14 Longman's Beaked Whale (*Indopacetus pacificus*)

4.1.14.1 Status and Management

Longman's beaked whale is protected under the MMPA and is not listed under the ESA. Only one, the Hawaiian stock, is identified for the Pacific (Carretta et al., 2017).

4.1.14.2 Habitat and Geographic Range

Longman's beaked whale is found in warm tropical waters, with most sightings occurring in waters with sea surface temperatures warmer than 78 °F (26°C) (Anderson et al., 2006; MacLeod & D'Amico, 2006; MacLeod et al., 2006). Although the full extent of this species' distribution is not fully understood, there have been many recorded sightings at various locations in tropical waters of the Pacific and Indian Oceans (Afsal et al., 2009; Dalebout et al., 2002; Dalebout et al., 2003; Moore, 1972). Sighting records of this species in the Indian Ocean showed that Longman's beaked whales are typically found in waters over deep bathymetric slopes of 200 to 2,000+ m (Anderson et al., 2006). In the Pacific, records of this species indicate presence in the eastern, central, and western Pacific, including waters off the coast of Mexico.

Based on systematic survey data collected from 1986-2005 in the eastern Pacific, all Longman's beaked whale sightings were south of 25° N (Hamilton et al., 2009).

There was a single sighting of approximately 18 Longman's beaked whales during the 2002 Hawaiian Islands Cetacean and Ecosystem Assessment survey (Barlow, 2006). During the follow-on 2010 survey, there were three sightings of Longman's beaked whales, with group sizes ranging from approximately 32 to 99 individuals (Bradford et al., 2017). Longman's beaked whales have also been sighted off Kona (Cascadia Research, 2012) and there have been two known strandings of this species in the main Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015d; West et al., 2012).

Longman's beaked whales are not present in the Southern California portion of the HSTT Study Area.

4.1.14.3 Population Trends

A change in the analysis methodology between the 2002 and 2010 surveys precludes evaluation of population trend for Longman's beaked whales at this time (Carretta et al., 2017).

4.1.15 Mesoplodont Beaked Whale (California, Washington Oregon stock)

4.1.15.1 Status and Management

The six species of Mesoplodont beaked whales known to occur off the U.S. west coast include Blainville's beaked whale (*M. densirostris*), Perrin's beaked whale (*M. perrini*), pygmy beaked whale (*M. peruvianus*), Stejneger's beaked whale (*M. stejnegeri*), Gingko-toothed beaked whale (*M. gingkodens*), and Hubbs' beaked whale (*M. carlhubbsi*). Due to the similarities between the species that make it

difficult to distinguish between them at-sea and as a result lacking species-specific abundance information, there is a single management unit encompassing all Mesoplodon stocks for waters off the U.S. west coast (Carretta et al., 2017). None of the *Mesoplodon* species are listed under the ESA.

4.1.15.2 Habitat and Geographic Range

Worldwide, beaked whales normally inhabit continental slope and deep ocean waters (greater than 200 m) and are only occasionally reported in waters over the continental shelf (Canadas et al., 2002; Ferguson et al., 2006b; MacLeod et al., 2006; Pitman, 2008; Waring et al., 2001). *Mesoplodon* beaked whales were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014).

Strandings along the U.S. west coast and elsewhere have provided some indication of marine mammal species range. Perrin's beaked whale is known only from five stranded specimens along the California coastline from 1975 to 1997 (Dalebout et al., 2002; MacLeod et al., 2006). These strandings include two at U.S. Marine Corps Base Camp Pendleton (33°15' N, 117°26' W), and one each at Carlsbad, (33°07' N, 117°20' W), Torrey Pines State Reserve (32°55' N, 117°15' W), and Monterey (36°37' N, 121°55' W) (Dalebout et al., 2002; Mead, 1981). Based on stranding data from the Pacific coast of Mexico, the pygmy beaked whale's range is thought to include deep waters off the Pacific coast of North America (Aurioles-Gamboa & Urban-Ramirez, 1993; Jefferson et al., 2008; Urban-Ramirez & Aurioles-Gamboa, 1992). This species was first described in 1991 from stranded specimens from Peru, and since then, strandings have been recorded along the coasts of both North and South America at Mexico, Peru, and Chile (Pitman & Lynn, 2001; Reyes et al., 1991; Sanino et al., 2007). MacLeod et al. (2006) suggested that the pygmy beaked whale occurs in the eastern Pacific from about 30° N to about 30° South (S). The handful of known records of the ginkgo-toothed beaked whale are from strandings, one of which occurred in California (Jefferson et al., 2015; MacLeod & D'Amico, 2006).

Acoustic monitoring has also provided information on the range for some *Mesoplodon* species in the Southern California portion of the HSTT Study Area. Beaked whales produce species-specific frequency modulated echolocation pulses and acoustic monitoring devices located at seven sites in the Southern California Bight have recorded the presence of sounds identified as Stejenger's beaked whales and recorded other beaked whale-like frequency modulated pulse types that may possibly be produced by Perrin's beaked whale, Hubbs' beaked whale, and pygmy beaked whales (Baumann-Pickering et al., 2014; Baumann-Pickering et al., 2015; Debich et al., 2015a).

4.1.15.3 Population Trends

A Bayesian trend analysis of systematic survey data collected from 1991 to 2008 suggested a decline in the abundance of beaked whales found in waters off California, Oregon, and Washington (Moore & Barlow, 2013). However, a more recent study (Barlow, 2016) included data from an additional survey conducted in 2014 and indicated that the pattern seen for the U.S. west coast from 1996 to 2014 may indicate a change in that downward trend. Given that the population trend for the entire U.S. west coast is uncertain, an additional trend analysis that includes data from the recent survey may be appropriate for beaked whales in the California/Oregon/Washington stock (Barlow, 2016). Moore and Barlow (2017) reported that based on new data collected during a 2014 US West Coast survey, Mesoplodon beaked whales showed markedly higher abundance in 2014, reversing a declining trend from 1991-2008 that had been noted in a previous analysis. The increase may have be driven by an influx of tropical species of Mesoplodon during the unusually warm ocean conditions in 2014.

4.1.16 Common Bottlenose Dolphin (*Tursiops truncatus*)

4.1.16.1 Status and Management

The common bottlenose dolphin is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, bottlenose dolphins within the Pacific U.S. Exclusive Economic Zone are divided into seven stocks: (1) Kauai and Niihau, (2) Oahu, (3) 4-Islands, (4) Hawaii Island, (5) the Hawaii Pelagic stock, (6) California Coastal stock, and (7) the California, Oregon and Washington Offshore stock (Carretta et al., 2017).

4.1.16.2 Habitat and Geographic Range

Common bottlenose dolphins typically are found in coastal and continental shelf waters of tropical and temperate regions of the world (Jefferson et al., 2008; Wells et al., 2009). Common bottlenose dolphins occur throughout the Hawaiian Islands, and they are typically observed throughout the main islands and from the Island of Hawaii to Kure Atoll (Baird et al., 2013d; Shallenberger, 1981). There were multiple common bottlenose dolphin sightings during both the 2002 (15 sightings) and 2010 (19 sightings) systematic surveys of the Hawaiian Exclusive Economic Zone (Barlow, 2006; Bradford et al., 2013). In the Hawaiian Islands, this species is found in both shallow coastal waters and deep offshore waters (Baird et al., 2003b; Barlow et al., 2008; Bradford et al., 2013; Mobley et al., 2000). The offshore variety is typically larger than the inshore. Photo-identification and genetics indicate the presence of island associated populations of bottlenose dolphins in the Hawaiian Islands (Martien et al., 2012). Bottlenose dolphins were observed during Navy monitoring surveys at Kaula Island in 2000, 2003, and 2009-2011 (Richie et al., 2012). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show some of the highest common bottlenose dolphin densities around the Hawaiian Islands (Becker et al., 2012b; Forney et al., 2015). Twelve stranding records from the main Hawaiian Islands exist (Maldini et al., 2005) (Maldini, 2003).

Four broad areas covering the main Hawaiian Islands have been identified for Small and Resident Populations of bottlenose dolphins (Baird et al., 2015b). These delineated areas are based on the range for each of the four recognized stocks around each island region with the offshore extent defined by the 1,000 m depth contour (Baird et al., 2015b).

Common bottlenose dolphins are known to occur year-round in both coastal and offshore waters of Monterey Bay, Santa Monica Bay, San Diego Bay, and San Clemente Island, California (Bearzi, 2005a, 2005b; Bearzi et al., 2009; Carretta et al., 2000; Henkel & Harvey, 2008). In the Southern California portion of the Study Area, they are routinely encountered in San Diego Bay in transit to the waters off Coronado where they feed (Graham & Saunders, 2015).

During surveys off California, offshore common bottlenose dolphins were generally found at distances greater than 1.9 mi. from the coast and throughout the waters of Southern California (Barlow & Forney, 2007; Barlow, 2016; Bearzi et al., 2009; Hamilton et al., 2009). Sighting records off California and Baja California suggest a continuous distribution of offshore common bottlenose dolphins in these regions (Mangels & Gerrodette, 1994). Analyses of sighting data collected during winter aerial surveys in 1991–1992 and summer shipboard surveys in 1991 indicated no significant seasonal shifts in distribution (Forney & Barlow, 1998). Based on habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. west coast, offshore common bottlenose dolphins exhibit a disjunctive longitudinal distribution, suggesting that there may be two separate populations in this area, although additional genetic data are required for confirmation (Becker et al., 2016).

California coastal bottlenose dolphins are found within about 0.6 NM of the shore, generally from Point Conception to as far south as San Quintin, Mexico (Carretta et al., 1998; Defran & Weller, 1999; Hwang et al., 2014). Coastal common bottlenose dolphins also have been consistently sighted off central California and as far north as San Francisco since the 1983-83 El Niño, when they apparently traveled further north tracking prey due to the northern extent of warmer waters and continued using those more northern waters after that El Niño had ended (Hwang et al., 2014). Off Southern California, animals are found within 500 m of the shoreline 99 percent of the time and within 250 m of the shoreline 90 percent of the time (Hanson & Defran, 1993; Hwang et al., 2014). The dolphins in the nearshore waters of San Diego, California differ somewhat from other coastal populations of this species in distribution, site fidelity, and school size (Bearzi, 2005a, 2005b; Carretta et al., 2017; Defran & Weller, 1999; Defran et al., 2015). Photo identification analyses suggest that there may be two separate stocks of coastal bottlenose dolphins that exhibit limited integration, a California Coastal stock and a Northern Baja California stock (Defran et al. 2015), but this is not yet reflected in the Pacific Stock Assessment Report (Carretta et al., 2017). The results from relatively contemporaneous surveys at Ensenada, San Diego, Santa Monica Bay, and Santa Barbara between 1996 and 2001 provided samples of the speed and distances individual coastal bottlenose dolphins routinely traveled (Hwang et al., 2014). The minimum travel speed observed was 53 km per day and the maximum was 95 km per day; and the total distances traveled between points was between 104 km and 965 km (Hwang et al., 2014).

4.1.16.3 Population Trends

For the Hawaiian Islands Stock Complex of common bottlenose dolphins, stock-specific abundance numbers and a provisional boundary between the pelagic and insular stocks of bottlenose dolphin in Hawaii have been presented in the most recent (2015) Pacific Stock Assessment Report (Carretta et al., 2017). For the Hawaii Pelagic stock, the large abundance difference between the 2002 and 2010 survey-based estimates and the overlapping confidence intervals preclude assessment of population trends with the available data (Carretta et al., 2017). For the four island associated insular stocks (Kauai and Niihau, Oahu, 4-Islands, and Hawaii Island), only one abundance estimate is available for each so there is insufficient information to assess population trends for those stocks (Carretta et al., 2017).

For the Southern California portion of the HSTT Study Area, the California Coastal stock population size has remained stable over the period for which data are available (Carretta et al., 2017; Dudzik et al., 2006). For the California, Oregon and Washington Offshore stock, there has been no trend analysis for the population (Carretta et al., 2017).

4.1.17 False Killer Whale (*Pseudorca crassidens*)

4.1.17.1 Status and Management

False killer whales are present in Hawaiian waters. NMFS currently recognizes three stocks of false killer whale in Hawaiian waters: the Hawaii pelagic stock, the Northwestern Hawaiian Islands stock, and the Main Hawaiian Islands insular stock (Bradford et al., 2015; Carretta et al., 2015; Forney et al., 2010; National Oceanic and Atmospheric Administration, 2012; Oleson et al., 2010). All stocks of false killer whale are protected under the MMPA. The Main Hawaiian Islands insular stock is listed as endangered under the ESA as a distinct population segment (National Oceanic and Atmospheric Administration, 2012). The Hawaii Pelagic stock and the Northwestern Hawaiian Islands stock of false killer whales, are not listed as threatened or endangered under the ESA. In July 2016, a complaint was filed in the United States District Court for the District of Columbia (Case 1:16-cv-01442; Filed 07/13/16) by the Natural Resources Defense Council against NMFS claiming that NMFS ”failed to timely designate” critical habitat

for Main Hawaiian Islands insular false killer whales. Consequently, a proposed designation of critical habitat for the species from NMFS is expected in late 2017.

The species is not expected to be present in the Southern California portion of the HSTT Study Area. False killer whales are not included by NMFS as a managed species in California waters (Carretta et al., 2017).

4.1.17.2 Habitat and Geographic Range

This species is known to occur in deep oceanic waters off Hawaii, and elsewhere in the Pacific false killer whales have been detected in acoustic surveys and are commonly observed in the eastern tropical Pacific generally south of the Study Area (Carretta et al., 2015; Miyashita et al., 1996; Oswald et al., 2003; Wade & Gerrodette, 1993; Wang et al., 2001). False killer whale are also regularly found within Hawaiian waters and have been reported in groups of up to 100 over a wide range of depths and distance from shore (Baird et al., 2003b; Baird et al., 2013a; Bradford et al., 2014; Bradford et al., 2015; Oleson et al., 2013; Shallenberger, 1981).

The ranges and stock boundary descriptions for false killer whales in the Hawaiian Islands are complex and overlapping. For example, all three stocks are known to overlap in the vicinity of Kauai and Niihau, which is where the Navy's underwater instrumented range has been in use since the 1980s. All significant information regarding the range of the three stocks (as of September 2015) was presented in Bradford et al. (2015). Carretta et al (2015) provided a summary of the data used to delineate the stock boundaries, summarized the research supporting that data, and provided a synthesis in the Pacific Stock Assessment Report that is repeated in the next few paragraphs for the stocks in the Hawaiian Islands.

The Main Hawaiian Islands insular stock is considered resident to the main Hawaiian Islands consisting of Kauai, Oahu, Molokai, Lanai, Kahoolawe, Maui, and Hawaii (Bradford et al., 2012; Bradford et al., 2015; Carretta et al., 2015; Forney et al., 2010; National Oceanic and Atmospheric Administration, 2012; Oleson et al., 2010). Individuals from this stock have been satellite tracked as far as 115 km from the main Hawaiian Islands (Baird et al., 2015e). The Main Hawaiian Islands insular stock boundary is a 72-km radius extending around the main Hawaiian Islands, with the offshore extent of the radii connected on the leeward sides of Hawaii Island and Niihau to encompass the offshore movements of Main Hawaiian Islands insular stock animals within that region. The waters outside of 11 km from shore from Oahu to Hawaii Island and out to the Main Hawaiian Islands insular stock boundary are an overlap zone between the Main Hawaiian Islands insular stock and Hawaii pelagic stock. In the waters around Kauai and Niihau there is also overlap between animals from the Main Hawaiian Islands insular stock and the Northwestern Hawaiian Islands stock.

A year-round Small and Resident Population area for the main Hawaiian Islands insular stock of false killer whales has been identified (Baird et al., 2015b). Satellite tag locations from 22 individuals from the stock were mapped to grid cells. Those grid cells having a density greater than one standard deviation of the mean were considered "high-use areas" and a boundary drawn around them then constituted the identified Small and Resident Population area for the stock.

Hawaii Pelagic stock animals have been tracked to within 11 km of the main Hawaiian Islands and throughout the Northwest Hawaiian Islands so the pelagic stock's inner boundary is placed at 11 km from shore (Bradford et al., 2015). The pelagic stock has no outer boundary and there is no inner boundary within the Northwestern Hawaiian Islands.

False killer whales in the Northwestern Hawaiian Islands stock have been seen as far as 93 km from the Northwestern Hawaiian Islands and near shore around Kauai and Oahu (Baird et al., 2012; Bradford et al., 2015). The Northwestern Hawaiian Islands stock boundary is defined by a 93-km radius around Kauai, Niihau, and the Northwestern Hawaiian Islands. The entirety of the Northwestern Hawaiian Islands stock range, with the exception of the area within 11 km around Kauai and Niihau is an overlap zone between Northwestern Hawaiian Islands stock and the Hawaii Pelagic stock false killer whales. The 93-km boundary radius around Kauai and Niihau for the Northwestern Hawaiian Islands stock partially overlaps the 72-km radius around those same islands for the Main Hawaiian Islands insular stock. In 2015, NMFS identified a biologically important area for the Main Hawaiian Islands stock as a small and resident population (Baird et al., 2015c), but that designation does not apply to animals in either the Northwestern Hawaiian Islands stock or the Hawaii Pelagic stock of false killer whales.

As noted previously, false killer whales are not expected to be present in the Southern California portion of HSTT. Older records document only a handful of sightings from areas such as Monterey Bay, Santa Catalina, and the Channel Islands (Baird, 2009; Jefferson et al., 2008; Miller & Scheffer, 1986). Sightings from vessel surveys also have occurred off in warmer waters off Baja California, Mexico (Chivers et al., 2007). False killer whales were not detected during the 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014). A nearshore marine mammal survey off San Diego Bay in March 2014 detected a false killer whale pod that was assumed to be the same pod that had been seen 6 days before off Dana Point (Graham & Saunders, 2015). Two years later in April–March 2016, a whale watch vessel out of Dana Point again sighted a pod of false killer whales in the same area (Ritchie, 2016). This species normally prefers warmer tropical waters found outside of southern California and the presence of this species to the north of its usual habitat was likely due to the warmer than normal water temperatures associated with a known El Niño event.

4.1.17.3 Population Trends

Reeves et al. (2009) suggested that the Main Hawaiian Islands Insular stock declined between 1989 and 2009. There are no data available for the current population trend for Main Hawaiian Islands Insular stock (Carretta et al., 2017). No data are available for the derivation of population trends for either the Hawaii Pelagic stock or the Northwestern Hawaiian Islands stock of false killer whales in Hawaii (Carretta et al., 2017).

4.1.18 Fraser's Dolphin (*Lagenodelphis hosei*)

Since its discovery in 1956, Fraser's dolphin was known only from skeletal specimens until it was once again identified in the early 1970s (Perrin et al., 1973). Although still one of the least-known species of cetaceans, Fraser's dolphin has become much better described as a species in recent years.

4.1.18.1 Status and Management

Fraser's dolphin is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands (Carretta et al., 2010).

4.1.18.2 Habitat and Geographic Range

In the offshore eastern tropical Pacific, this species is distributed mainly in upwelling modified waters (Aguayo & Sanchez, 1987; Au & Perryman, 1985; Ferguson, 2005; Miyazaki & Wada, 1978; Reilly, 1990).

Fraser's dolphins have been documented within Hawaiian waters with the first published sightings occurring during a 2002 cetacean survey (Barlow, 2006). Fraser's dolphin vocalizations have also been documented in the Hawaiian Islands (Barlow et al., 2004; Barlow et al., 2008). Based on line-transect survey data collected in summer/fall of 2010, Fraser's dolphin was one of the most abundant species within the Exclusive Economic Zone ocean areas around the Hawaiian Islands; having a notably large group size in the pods observed with a mean of 283 animals (Bradford et al., 2013). In small boat surveys nearshore around the Hawaiian Islands, Fraser's dolphins have only been seen twice in 10 years (both times off the Kona Coast of Hawaii Island) (Baird et al., 2013c). It is not known whether Fraser's dolphins found in Hawaiian waters are part of the same population that occurs in the eastern tropical Pacific (Carretta et al., 2010). There are no records of strandings of this species in the Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015d).

Fraser's dolphins are not present in the Southern California portion of the HSTT Study Area.

4.1.18.3 Population Trends

No data are available on current population trend for the Hawaiian stock of Fraser's dolphin (Carretta et al., 2015).

4.1.19 KILLER WHALE (*ORCINUS ORCA*)

A single species of killer whale is currently recognized, but strong and increasing evidence indicates the possibility of several different species of killer whales worldwide, many of which are called "ecotypes" (Ford 2008). The different geographic forms of killer whale are distinguished by distinct social and foraging behaviors and other ecological traits. In the north Pacific, these recognizable geographic forms are variously known as ''residents,'' ''transients," and "offshore" ecotypes (Hoelzel et al. 2007). In the HSTT Study Area, both the transient and offshore ecotypes are known to occur.

4.1.19.1 Status and Management

Five killer whale stocks are recognized within the Pacific U.S. Exclusive Economic Zone, with only the Hawaiian stock occurring in Hawaii and two stocks in the Southern California portion of the HSTT Study Area consisting of the Eastern North Pacific Transient/West Coast Transient stock[5] and the Eastern North Pacific Offshore stock (Carretta et al., 2017). Killer whales are protected under the MMPA and the three stocks present in the HSTT Study Area are not ESA listed.

4.1.19.2 Habitat and Geographic Range

Killer whales are found in all marine habitats from the coastal zone (including most bays and inshore channels) to deep oceanic basins and from equatorial regions to the polar pack ice zones of both hemispheres. Although killer whales are also found in tropical waters and the open ocean, they are most numerous in coastal waters and at higher latitudes (Dahlheim & Heyning, 1999). Forney and Wade (2006) found that killer whale densities increased by 1-2 orders of magnitude from the tropics to the poles.

[5] This stock is mentioned briefly in the Pacific Stock Assessment Report (Carretta et al. 2016) and referred to as the "Eastern North Pacific Transient" stock, but the Alaska Stock Assessment Report contains assessments of the killer whale transient stocks where this same stock is referred to as the "West Coast Transient" stock (Muto et al. 2016).

Although killer whales apparently prefer cooler waters, they have been observed in Hawaiian waters (Baird et al., 2013d; Barlow, 2006; Mobley et al., 2001a; Shallenberger, 1981). There are also documented strandings for this species from the Hawaiian Islands (Maldini et al., 2005). Sightings are extremely infrequent in Hawaiian waters, and typically occur during winter, suggesting those sighted in Hawaii are seasonal migrants to Hawaii (Baird et al., 2003a; Baird et al., 2013d; Mobley et al., 2001a). During two separate systematic ship surveys of the Hawaiian Exclusive Economic Zone in summer/fall, there were two killer whale sightings in 2002 and a single sighting in 2010 (Barlow, 2006; Bradford et al., 2017). Baird (2006) documented 21 killer whale sightings within the Hawaiian Exclusive Economic Zone, primarily around the main Hawaiian Islands during relatively nearshore small boat surveys. In the period from 2000 to 2012, there were two sightings with each pod consisting of four killer whales (Baird et al., 2013c). A single adult female was also sighted off Kauai in July 2011 (Cascadia Research Collective, 2012). A pod of killer whales was observed off the southwest coast of the island of Hawaii in May 2013 (Pacific Fishery Management Council, 2014).

All three ecotypes of killer whale are known to occur along the west coast of North America, from the entire Alaskan coast, in British Columbia and Washington inland waterways, and along the outer coasts of Washington, Oregon, and California but the endangered resident ecotype's range does not extend south of Monterey California (Calambokidis & Barlow, 2004; Carretta et al., 2017; Dahlheim et al., 2008; Ford & Ellis, 1999; Forney et al., 1995). In the Southern California portion of the HSTT Study Area, only the transient and offshore ecotypes may be present (Carretta et al., 2017). During seven systematic ship surveys of waters off the U.S. west coast between 1991 and 2014, there were 37 killer whale sightings, only five of which were off southern California (Henderson et al., 2016). Based on two sightings from 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012, killer whales were ranked 12th in occurrence as compared to other cetaceans (Jefferson et al., 2014; Smultea et al., 2014).

4.1.19.3 Population Trends

No data are available on current population trends for the Hawaii stock of killer whales or in the Southern California portion of the HSTT Study Area, for either the Eastern North Pacific offshore or Eastern North Pacific Transient/West Coast Transient stock of killer whales (Carretta et al., 2017; Muto et al., 2017).

4.1.20 Long-beaked Common Dolphin (*Delphinus capensis*)

Common dolphins are represented by two species for management purposes in the NMFS Pacific Stock Assessment Report (Carretta et al., 2017), the long-beaked common dolphin (*Delphinus capensis*) and the short-beaked common dolphin (*Delphinus delphis*). There is scientific disagreement regarding the common dolphin taxonomy (Committee on Taxonomy, 2016), but the Navy is following the NMFS naming convention.

4.1.20.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, there is a single Pacific management stock for those animals found within the U.S. Exclusive Economic Zone off the U.S. west coast, which is called the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.20.2 Habitat and Geographic Range

Long-beaked common dolphins are not present in the Hawaii portion of the HSTT Study Area.

The long-beaked common dolphin appears to be restricted to waters relatively close to shore (Jefferson & Van Waerebeek, 2002; Perrin, 2008b), apparently preferring shallower and warmer water than the short-beaked common dolphin (Becker et al., 2016; Perrin, 2008b). Off California and Baja California, Mexico, long-beaked common dolphins are commonly found within 50 NM of the coast (Carretta et al., 2011; Gerrodette & Eguchi, 2011). This species is found off Southern California year round, but it may be more abundant there during the warm-water months (May to October) (Barlow & Forney, 2007; Bearzi, 2005b; Douglas et al., 2014b; Henderson et al., 2014a; Heyning & Perrin, 1994). Stranding data and sighting records suggest that this species' abundance fluctuates seasonally and from year to year off California (Carretta et al., 2011; Douglas et al., 2014b; Henderson et al., 2014a). Southern California waters represent the northern limit to this species' range and the seasonal and inter-annual changes in abundance off California are assumed to reflect the shifts in the movements of animals between U.S. and Mexican waters (Carretta et al., 2017).

4.1.20.3 Population Trends

There appears to be an increasing trend in the abundance of long-beaked common dolphin in southern California waters over the last 30 years (Carretta et al., 2017; Jefferson et al., 2014).

4.1.21 MELON-HEADED WHALE (*PEPONOCEPHALA ELECTRA*)

4.1.21.1 Status and Management

The melon-headed whale is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, there are two Pacific management stocks within the Hawaiian Islands Exclusive Economic Zone based on photo-identification, social network analysis, movement data, and genetics (Oleson et al., 2013). These stock are (1) the Kohala Resident stock, which includes melon-headed whales off the Kohala and west coast of Hawaii Island in waters less than 2,500 m deep; and (2) the Hawaiian Islands stock, which includes melon-headed whales inhabiting waters throughout the U.S. Exclusive Economic Zone of the Hawaiian Islands (Aschettino et al., 2012; Baird et al., 2015c; Carretta et al., 2017; Oleson et al., 2013).

4.1.21.2 Habitat and Geographic Range

Melon-headed whales are found worldwide in tropical and subtropical waters but movement patterns for this species are poorly understood. They have occasionally been reported at higher latitudes, but these movements are considered to be beyond their normal range, because the records indicate these movements occurred during incursions of warm water currents (Jefferson et al., 2015; Perryman et al., 1994; Perryman, 2008). In the north Pacific, occurrence of this species is well known in deep waters off many areas, including the Hawaii portion of the Study Area (Aschettino et al., 2012; Au & Perryman, 1985; Ferguson, 2005; Perrin, 1976; Wang et al., 2001).

The melon-headed whale is regularly found within Hawaiian waters (Baird et al., 2003a; Baird et al., 2003b; Baird et al., 2010; Baird et al., 2015d; Mobley et al., 2000; Shallenberger, 1981). Large groups are seen regularly, especially off the Waianae coast of Oahu, the north Kohala coast of Hawaii, and the leeward coast of Lanai (Baird, 2006; Oleson et al., 2013; Shallenberger, 1981). A line-transect survey conducted in February 2009 by the Cetacean Research Program surrounding the Hawaiian Islands resulted in the sighting of a single melon-headed whale (Oleson and Hill 2009). Two ship-based, visual

line-transect surveys were conducted during the summer-fall of 2002 and 2010 in the U.S. Exclusive Economic Zone of the Hawaiian Islands and also encountered single groups of 89 melon-headed whales (Baird, 2006) and 153 melon-headed whales (Bradford et al., 2013), respectively.

Brownell et al. (2009) found that melon-headed whales near oceanic islands rest near shore during the day, and feed in deeper waters at night. Melon-headed whales are known to enter shallow water areas on occasion although these are generally characterized as animals being “out of habitat” and/or “mass strandings”; a few hundred did so at Hanalei Bay, Kauai and Sasanhaya Bay, Rota (Mariana Islands) on July 4, 2004 (Jefferson et al., 2006), and similar numbers did so in the Philippines entering Manila Bay in Feb 2009 and the bay at Odiongan, Romblon in March of 2009 (Aragones et al., 2010). In surveys around the main Hawaiian Islands, melon-headed whales showed no clear pattern in depth use (Baird et al., 2013c).

A year-round Small and Resident Population area has been identified for melon-headed whales off the Island of Hawaii (Baird et al., 2015b). The delineated area forms a roughly triangular polygon centered off Kawaihae (Hawaii Island) as determined by a polygon drawn around the locations from four satellite-tagged individuals, photo-identification data, extensive vessel-based survey data, and expert judgment (Baird et al., 2015b).

During ship-based bird surveys in the eastern tropical Pacific, this species was observed from the U.S.-Mexico border south to Peru, typically associated with pelagic sea birds while foraging (Pitman & Ballance, 1992). The species is not expected to be present in the Southern California portion of the HSTT Study Area.

4.1.21.3 Population Trends

Because there are only two estimates of abundance available from survey data, no population trend analysis has been possible for melon-headed whales in Hawaii (Carretta et al., 2015).

4.1.22 Northern Right Whale Dolphin (*Lissodelphis borealis*)

4.1.22.1 Status and Management

This species it is not listed under the ESA but is protected by the MMPA. The management stock in U.S. waters consists of a single California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.22.2 Habitat and Geographic Range

The northern right whale dolphin occurs in cool-temperate to subarctic waters of the North Pacific Ocean, from the west coast of North America to Japan and Russia. This oceanic species is distributed from approximately 30°N to 50°N, 145°W to 118° East and generally not as far north as the Bering Sea (Jefferson et al., 2015). Occasional movements south of 30°N are associated with unusually cold water temperatures (Jefferson & Lynn, 1994). This species tends to occur along the outer continental shelf and slope, normally in waters colder than 68°F (20°C) (Jefferson & Lynn, 1994). Northern right whale dolphins generally move nearshore only in areas where the continental shelf is narrow or where productivity on the shelf is especially high (Smith et al., 1986).

Northern right whale dolphins are not present in the Hawaii portion of the HSTT Study Area.

Off California, the northern right whale dolphin is known to occur year-round, but abundance and distribution vary seasonally (Becker et al., 2014; Dohl et al., 1983; Douglas et al., 2014b; Forney & Barlow, 1998). Northern right whale dolphins are primarily found off California during the colder water months, with distribution shifting northward into Oregon and Washington as water temperatures increase during late spring and summer (Barlow, 1995; Forney et al., 1995; Forney & Barlow, 1998; Henderson et al., 2014a). In the cool water period, the peak abundance of northern right whale dolphins in the Southern California portion of the Study Area corresponds closely with the peak abundance of squid (Forney & Barlow, 1998; Jefferson & Lynn, 1994). Northern right whale dolphins were sighted year-round during 16 ship surveys conducted from 2004 to 2008 off southern California, but the majority of the sightings were in winter and spring (Douglas et al., 2014b). There were 16 sightings of northern right whale dolphins during 18 aerial surveys conducted in the southern California Bight from 2008 to 2013 (Jefferson et al., 2014).

As noted above, in the warm water periods, the northern right whale dolphin is not as abundant in Southern California due to shifting distributions north into Oregon and Washington (Barlow, 1995; Forney et al., 1995; Forney & Barlow, 1998). Based on habitat models developed with line-transect survey data collected off the U.S. west coast during summer and fall from 1991 to 2009, Becker et al. (2016) found that encounters of northern right whale dolphin increased in shelf and slope waters, and encounters decreased substantially in waters warmer than approximately 64°F (18°C). These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012). Northern right whale dolphins also tend to occur further offshore of southern California during the summer months (Douglas et al., 2014b; Forney & Barlow, 1998).

4.1.22.3 Population Trends

Examination of sighting and stranding data from the 1950s through 2012 suggest that the relative occurrence of northern right whale dolphin in the Southern California Bight has not changed over that period (Smultea & Jefferson, 2014) and the Pacific Stock Assessment Report indicates there is there is no evidence of a trend in abundance for this stock (Carretta et al., 2017).

4.1.23 Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)

4.1.23.1 Status and Management

This species is not listed under the ESA but is protected under the MMPA. NMFS recognizes a single stock, the California, Oregon, and Washington stock for the U.S. west coast (Carretta et al., 2017).

4.1.23.2 Habitat and Geographic Range

Pacific white-sided dolphins are not present in the Hawaii portion of the HSTT Study Area.

Pacific white-sided dolphins are found in cold temperate waters across the northern rim of the Pacific Ocean as far north as the southern Bering Sea and as far south as the Gulf of California off Mexico (Ferguson, 2005; Jefferson et al., 2015; Leatherwood et al., 1984; Reeves et al., 2002b). It is also known to inhabit inshore regions of southeast Alaska, British Columbia, and Washington, and occurs seasonally off Southern California (Brownell et al., 1999; Forney & Barlow, 1998). Sighting records and captures in open sea driftnets indicate that this species also occurs in oceanic waters well beyond the shelf and slope (Ferrero & Walker, 1996; Leatherwood et al., 1984).

Off California, Forney and Barlow (1998) found significant north/south shifts in the seasonal distribution of Pacific white-sided dolphin, with the animals moving north into Oregon and Washington waters during the summer, and showing increased abundance in the Southern California Bight in the winter. During ship surveys conducted off the U.S. west coast in the summer and fall from 1991 to 2005, the number of Pacific white-sided dolphin sightings showed no clear pattern with respect to geographic region, although they were consistently found in larger groups off central California (Barlow & Forney, 2007; Henderson et al., 2014a). Based on habitat models developed with survey data collected during summer and fall from 1991 to 2009, Becker et al. (2016) found that encounters of Pacific white-sided dolphin increased in shelf and slope waters and in relatively cooler waters in the study area. These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012). Based on ship survey data collected quarterly from 2004 to 2013, Pacific white-sided dolphins occurred year-round off southern California, but the majority of the sightings were in winter and spring when their distribution was more widespread (Campbell et al., 2014). There were 21 sightings of Pacific white-sided dolphin during 18 aerial surveys conducted in the southern California Bight from 2008 to 2013 (Jefferson et al., 2014).

4.1.23.3 Population Trends

Multiple analyses of sightings and stranding data have indicated a significant decline in abundance over time from the Southern California Bight to the Gulf of California in Mexico (Barlow, 2016; Campbell et al., 2015; Salvadeo et al., 2010; Smultea & Jefferson, 2014).

4.1.24 Pantropical Spotted Dolphin (*Stenella attenuata*)

4.1.24.1 Status and Management

The species is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, the species has been divided into four stocks based on genetics and the frequency of sightings in pelagic waters around Hawaii (Courbis et al., 2014; Oleson et al., 2013). For the MMPA stock assessment reports, the four management stocks within the Hawaiian Islands Exclusive Economic Zone are (1) the Oahu stock, which includes spotted dolphins within 20 km of Oahu; (2) the 4-Islands stock, which includes spotted dolphins within 20 km of the island group formed by Maui, Molokai, Lanai, and Kahoolawe and their adjacent waters; (3) the Hawaii Island stock, which includes spotted dolphins found within 65 km from Hawaii Island; and (4) the Hawaii Pelagic stock, which includes spotted dolphins inhabiting the waters throughout the Hawaiian Islands Exclusive Economic Zone, outside of the insular stock areas (Carretta et al., 2017).

4.1.24.2 Habitat and Geographic Range

The pantropical spotted dolphin is distributed in offshore tropical and subtropical waters of the Pacific, Atlantic, and Indian Oceans between about 40° N and 40° S (Baldwin et al., 1999; Perrin, 2008a). The species is much more abundant in the lower latitudes of its range. It is found mostly in deeper offshore waters but does approach the coast in some areas (Jefferson et al., 2008; Perrin, 2001).

Based on sightings during small boat surveys from 2000 to 2012 in the main Hawaiian Islands, pantropical spotted dolphins were the most abundant species of cetacean, although they were frequently observed leaping out of the water which likely increased their detectability (Baird et al., 2013d). This species was also one of the most abundant based on analyses of line-transect data collected in the Hawaiian Exclusive Economic Zone in 2002 and 2010 (Barlow, 2006; Bradford et al.,

2013). Known habitat preferences and sighting data indicate the primary occurrence for the pantropical spotted dolphin in Hawaiian waters is shallow coastal waters to depths of 5,000 m, although the peak sighting rates occur in depths from 1,500 to 3,500 m (Baird et al., 2013e; Bradford et al., 2013; Oleson et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show relatively high pantropical spotted dolphin densities around the Hawaiian Islands, particularly around the Main Hawaiian Islands (Becker et al., 2012a; Forney et al., 2015), consistent with sightings from two systematic ship surveys of the Hawaiian Exclusive Economic Zone (Barlow, 2006; Bradford et al., 2017).

A year-round Small and Resident Population area has been identified for pantropical spotted dolphins around the main Hawaiian Islands (Baird et al., 2015b). Sighting data from small-boat surveys were used to delineate the three locations forming this area but these data are biased by survey effort that has occurred mainly off the protected leeward sides of the Hawaiian Islands (Baird et al., 2015b).

Pantropical spotted dolphins are not present in the Southern California portion of the HSTT Study Area.

4.1.24.3 Population Trends

No data are available on current population trend for any of the stocks of pantropical spotted dolphins in Hawaii (Carretta et al., 2017).

4.1.25 Pygmy Killer Whale (*Feresa attenuata*)

4.1.25.1 Status and Management

The pygmy killer whale is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, there is a single Pacific management stock including only animals found within the U.S. Exclusive Economic Zone of the Hawaiian Islands (Bradford et al., 2013; Carretta et al., 2010; Oleson et al., 2013).

4.1.25.2 Habitat and Geographic Range

The pygmy killer whale is generally an open ocean deepwater species (Davis et al., 2000; McSweeney et al., 2009; Oleson et al., 2013; Würsig et al., 2000). Movement patterns for this species are poorly understood. During a NMFS 2014 systematic ship survey off the U.S. west coast, when there were unusually warm water conditions, a group of 27 pygmy killer whales was sighted in offshore waters of southern California (Barlow, 2016). Given that there is a remote likelihood for this species to occur regularly off the U.S. west coast, the 2015 Pacific Stock Assessment report does not include pygmy killer whales as a managed stock in California waters (Carretta et al., 2017).

This species' range in the open ocean generally extends to the southern regions of the North Pacific Gyre and the southern portions of the North Pacific Transition Zone. Many sightings have occurred from cetacean surveys of the eastern tropical Pacific (Au & Perryman, 1985; Barlow & Gisiner, 2006; Wade & Gerrodette, 1993). This species is also known to be present in the western Pacific (Wang & Yang, 2006). Its range is generally considered to be south of 40° N and continuous across the Pacific (Donahue & Perryman, 2008; Jefferson et al., 2008). Groups of pygmy killer whales were sighted five times during NMFS 2010 survey of the Hawaiian Islands (Bradford et al., 2017).

A year-round Small and Resident Population area has been identified for pygmy killer whales off the Island of Hawaii (Baird et al., 2015b). The delineated area extends along the coast of Hawaii Island from

northwest of Kawaihae to South Point and along the southeast coast of the island, as determined by locations from two satellite-tagged individuals, photo-identification data, extensive vessel-based survey data, and expert judgment (Baird et al., 2015b).

4.1.25.3 Population Trends

No data are available regarding the trends for populations of pygmy killer whales in the Pacific (Carretta et al., 2015).

4.1.26 Risso's Dolphin (*Grampus griseus*)

4.1.26.1 Status and Management

Risso's dolphin is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, Risso's dolphins within the Pacific U.S. Exclusive Economic Zone are divided into two separate stocks: the Hawaiian stock in Hawaiian waters and the California, Oregon and Washington stock in the Southern California portion of the HSTT Study Area (Carretta et al., 2017).

4.1.26.2 Habitat and Geographic Range

In the Pacific, Risso's dolphins are found in the waters around the Hawaiian Islands (Bradford et al., 2017) and off the U.S. west coast (Barlow, 2016). Studies have documented that Risso's dolphins are found along the continental slope, over the outer continental shelf (Baumgartner, 1997; Canadas et al., 2002; Cetacean and Turtle Assessment Program, 1982; Davis et al., 1998; Green et al., 1992; Kruse et al., 1999; Mignucci-Giannoni, 1998), and over submarine canyons (Mussi et al., 2004).

Risso's dolphins had been considered rare in Hawaiian waters (Shallenberger, 1981). However, during a 2002 survey of the Hawaiian Islands U.S. Exclusive Economic Zone, seven sightings were reported; in addition, two sightings were reported from aerial surveys in the Hawaiian Islands (Barlow, 2006; Mobley et al., 2000). During a more recent 2010 systematic survey of the Hawaiian Islands U.S. Exclusive Economic Zone, there were 13 sightings of Risso's dolphins (Bradford et al., 2017). In December–January 2014 using a passive acoustic recording device onboard an unmanned glider south of Oahu, Risso's dolphins were acoustically detected throughout the entire survey except for the southernmost part between Bishop Seamount and McCall Seamount (Klinck et al., 2015). In addition, Risso's dolphins were sighted eight times during Navy monitoring activities within the Hawaii Range Complex between 2005 and 2012 (HDR, 2012). Seven stranding records exist from the main Hawaiian Islands (Maldini et al., 2005; National Marine Fisheries Service, 2015d).

Risso's dolphin exhibits an apparent seasonal shift in distribution off the U.S. west coast, with movements from California waters north into Oregon and Washington waters in summer (Carretta et al., 2000; Forney & Barlow, 1998; Green et al., 1992; Soldevilla et al., 2008). During ship surveys conducted quarterly off Southern California from 2004 to 2008, Risso's dolphins were encountered year-round, with highest encounters during the cold-water months (Douglas et al., 2014b), consistent with previously observed seasonal shifts in distribution (Carretta et al., 2000; Forney & Barlow, 1998; Henderson et al., 2014a; Soldevilla, 2008). Off California, they are commonly seen over the slope and in offshore waters (Barlow & Forney, 2007; Forney et al., 1995; Jefferson et al., 2008). This species is frequently observed in the waters surrounding San Clemente Island, California (Carretta et al., 2000). Habitat models derived from line-transect survey data collected between 1991 and 2009 off the U.S. west coast show that Risso's dolphins exhibit a disjunctive longitudinal distribution, suggesting that there may be two separate populations in this area, although additional genetic data are required for

confirmation (Becker et al., 2016). Several stranding records have been documented for this species in central and Southern California between 1977 and 2002 (Zagzebski et al., 2006).

4.1.26.3 Population Trends

In Hawaii, the broad and overlapping confidence intervals around the two Hawaii survey estimates of abundance preclude any assessment of a trend for this population (Carretta et al., 2015).

For Risso's dolphins in California, Oregon, and Washington waters, differences in estimated abundance between survey years is most likely due to the inter-annual variability in species distribution rather than a true abundance trend (Carretta et al., 2015). However, based on density estimates derived from aerial survey data collected from 2008 to 2013, the abundance of Risso's dolphin in Southern California waters appears to have increased (Jefferson et al., 2014). Further, examination of sighting and stranding data from the 1950s through 2012 also indicated an increase in the relative occurrence of this species in the Southern California Bight over this time period (Smultea & Jefferson, 2014).

4.1.27 ROUGH-TOOTHED DOLPHIN (*STENO BREDANENSIS*)

4.1.27.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. Rough-toothed dolphins are among the most widely distributed species of tropical dolphins, but little information is available regarding population status (Jefferson et al., 2015). There is a single Pacific management stock for rough-toothed dolphins found within the U.S. Exclusive Economic Zone of the Hawaiian Islands, but there is no recognized stock of rough-toothed dolphins for the U.S. west coast (Carretta et al., 2017).

4.1.27.2 Habitat and Geographic Range

Rough-toothed dolphins are well known in deep ocean waters off the Hawaiian Islands but are also seen relatively frequently during nearshore surveys (Baird et al., 2008; Baird et al., 2015e; Barlow et al., 2008; Bradford et al., 2013; Carretta et al., 2015; Pitman & Stinchcomb, 2002; Shallenberger, 1981; Webster et al., 2015). During NMFS 2010 survey of the Hawaiian Islands, this species was encountered 24 times and has been observed as far northwest as Pearl and Hermes Reef in the Northwest Hawaiian Islands (Bradford et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show the strong island association of rough-toothed dolphins (Becker et al., 2012b; Forney et al., 2015). Over a 10-day near-shore survey effort off Kauai in 2014, rough-toothed dolphins were encountered on two occasions and 7 of the 8 individuals photo-identified had been observed in previous years (Baird et al., 2015d). Data from 14 satellite tags deployed off Kauai between 2011–2015 on rough-toothed dolphins indicated a large portion of the core area for those animals overlaps the Pacific Missile Range Facility range and the channel between Kauai and Niihau (Baird et al., 2015d). The data presented by Baird et al. (2015d) and Webster et al. (2015) are indicative of residency on or near the Pacific Missile Range Facility range by some of those animals (see also (Baird et al., 2008). Because there are insufficient data at present, the area has not been identified as a biologically important area for this small resident population off Kauai (Baird et al., 2015c).

Unpublished data from small boat surveys off the west coast of Hawaii Island between 2002–2014 have provided sighting locations and genetic evidence indicative of another resident population, resulting in the identification of a biologically important area for that population (Baird et al., 2015c). The delineated area is a rough triangle encompassing all the locations where rough-toothed dolphins were sighted during those surveys (Baird et al., 2015c).

The range of the rough-toothed dolphin is known to include the southern portion of the California coast but there is no recognized stock for the U.S west coast (Carretta et al., 2015). Three strandings were documented for this species in central and Southern California between 1977 and 2002 with pneumonia identified as a cause of death (Zagzebski et al. 2006). This species has not been observed during seven systematic ship surveys from 1991 to 2014 off the U.S. west coast (Barlow, 2016). During 16 quarterly ship surveys off southern California from 2004 to 2008, there was one encounter with a group of 9 rough-toothed dolphins, which was considered an extralimital occurrence (Douglas et al., 2014b).

4.1.27.3 Population Trends

The large abundance difference between the 2002 and 2010 survey-based estimates and the overlapping confidence intervals for rough-toothed dolphins preclude assessment of population trends with the available data (Carretta et al., 2017).

4.1.28 Short-beaked Common Dolphin (*Delphinus delphis*)

Common dolphins are represented by two species for management purposes in the NMFS Pacific Stock Assessment Report (Carretta et al., 2017), the short-beaked common dolphin (*Delphinus delphis*) and long-beaked common dolphin (*Delphinus capensis*). There is scientific disagreement regarding the common dolphin taxonomy (Committee on Taxonomy, 2016), but the Navy is following the NMFS naming convention.

4.1.28.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. For the MMPA stock assessment reports, there is a single Pacific management stock for those animals found within the U.S. Exclusive Economic Zone off the U.S. west coast, which is called the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.28.2 Habitat and Geographic Range

Short-beaked common dolphins are not present in the Hawaii portion of the HSTT Study Area.

Historically along the U.S. west coast, short-beaked common dolphins were sighted primarily south of Point Conception (Dohl et al., 1983), but now they are commonly encountered as far north as 42°N (Hamilton et al., 2009), and occasionally as far north as 48°N (Forney, 2007). Seasonal distribution shifts are pronounced, with a significant southerly shift south of Point Arguello in the winter (Becker et al., 2014; Campbell et al., 2014; Forney & Barlow, 1998; Henderson et al., 2014a). Short-beaked common dolphins are a warm temperate to tropical species, and based on habitat models developed using line-transect survey data collected off the U.S. west coast, densities are greatest when waters are warmest (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2014; Becker et al., 2016; Forney & Barlow, 1998; Forney et al., 2012). The abundance of short-beaked common dolphins off the U.S. west coast varies, with seasonal and year-to-year changes in oceanographic conditions; movements may be north-south or inshore-offshore (Barlow et al., 2009; Becker et al., 2014; Becker et al., 2016; Forney & Barlow, 1998; Forney et al., 2012; Henderson et al., 2014a). Short-beaked common dolphin abundance off California has increased dramatically since the late 1970s, along with a smaller decrease in abundance in the eastern tropical Pacific, suggesting a large-scale northward shift in the distribution of this species in the eastern North Pacific (Carretta et al., 2017; Forney et al., 1995; Forney & Barlow, 1998). The trend for an increase in the population off California appears to be continuing given the current data from the most recent 2014 NMFS survey (Barlow, 2016).

Short-beaked common dolphins are found in the Southern California portion of the HSTT Study Area throughout the year, distributed between the coast and at least 345 mi. from shore (Barlow & Forney, 2007; Barlow, 2016; Forney & Barlow, 1998). Based on multiple line-transect studies conducted by NMFS, the short-beaked common dolphin is the most abundant cetacean species with a widespread distribution off southern California (Barlow & Forney, 2007; Barlow, 2016; Campbell et al., 2014; Carretta et al., 2011; Douglas et al., 2014b; Forney et al., 1995). From 2004 to 2008 during ship surveys conducted quarterly by the state of California off southern California, short-beaked common dolphins were encountered year-round, with highest encounters during the summer (Douglas et al., 2014b). From 2008 to 2013 during 18 aerial surveys conducted in the Southern California Bight, short-beaked common dolphins were the most-frequently observed species (Jefferson et al., 2014).

4.1.28.3 Population Trends

Based on an analysis of sighting data collected during quarterly surveys off southern California from 2004 to 2013, short-beaked common dolphins showed annual variations in density, but there was no significant trend evident during the period of this study (Campbell et al., 2014) or as a result of any other data (Carretta et al., 2017). However, Barlow (2016) noted a nearly monotonic increase in the abundance of short-beaked common dolphins from 1991 to 2014 off the U.S. west coast, and suggested that a future trend analysis is appropriate.

4.1.29 Short-finned Pilot Whale (*Globicephala macrorhynchus*)

4.1.29.1 Status and Management

Short-finned pilot whales are protected under the MMPA and are not listed under the ESA. For MMPA stock assessment reports, short-finned pilot whales within the Pacific U.S. Exclusive Economic Zone are divided into two discrete stocks: (1) the Hawaiian stock, and (2) the California, Oregon and Washington stock (Carretta et al., 2017).

4.1.29.2 Habitat and Geographic Range

The short-finned pilot whale is widely distributed throughout most tropical and warm temperate waters of the world and occurs in waters over the continental shelf break, in slope waters, and in areas of high topographic relief (Baird et al., 2013c; Olson, 2009). While pilot whales are typically distributed along the continental shelf break, movements over the continental shelf are commonly observed in the northeastern United States (Payne & Heinemann, 1993) and close to shore at oceanic islands like Hawaii, where the shelf is narrow and deeper waters are found nearby (Baird, 2013; Gannier, 2000; Mignucci-Giannoni, 1998). Short-finned pilot whales are not considered a migratory species, although seasonal shifts in abundance have been noted in some portions of the species' range. A number of studies in different regions suggest that the distribution and seasonal inshore/offshore movements of pilot whales coincide closely with the abundance of squid, their preferred prey (Bernard & Reilly, 1999; Hui, 1985; Payne & Heinemann, 1993).

Short-finned pilot whales in the Hawaiian Islands were the most commonly encountered species of odontocete during near-shore surveys in depths over 2,000 m and were the second most common odontocete encountered during the NMFS 2002 (25 sightings) and 2010 (36 sightings) systematic ship surveys of the Hawaiian Exclusive Economic Zone (Baird et al., 2013c; Barlow, 2006; Bradford et al., 2013; Oleson et al., 2013). Small boat surveys from 2003 through 2007 photo-identified 250 individuals seen in more than one year, suggesting site fidelity (Abecassis et al., 2015; Mahaffy et al., 2015; Oleson et al., 2013). Habitat-based models developed from systematic ship survey data collected in the central

North Pacific show some of the highest short-finned pilot whale densities around the Hawaiian Islands (Becker et al., 2012b; Forney et al., 2015). Twenty-three strandings of this species have been recorded at the main Hawaiian Islands, including five mass strandings and four strandings since 2007 (Carretta et al., 2015; Maldini et al., 2005).

A year-round Small and Resident Population area has been identified for short-finned pilot whales off the Island of Hawaii (Baird et al., 2015b). The delineated area extends along the coast of Hawaii Island as determined by a polygon drawn around the locations from 35 satellite-tagged deployments defining a high-use area (Baird et al., 2015b; Mahaffy et al., 2015).

Short-finned pilot whale distribution off Southern California changed dramatically after El Niño in 1982–1983, when squid did not spawn as usual in the area, and pilot whales virtually disappeared from the area for 9 years (Shane, 1995). There have been nine short-finned pilot whale sightings during seven systematic ship surveys conducted by NMFS off California, Oregon, and Washington between 1991 and 2014, with three of these off southern California (Barlow & Forney, 2007; Barlow, 2016). There were two additional short-finned pilot whale sightings during 16 ship surveys conducted by the state of California in the Southern California Bight between 2004 and 2008 (Douglas et al., 2014b). Short-finned pilot whales were not sighted during 18 aerial surveys conducted in the Southern California Bight between 2008 and 2013 (Jefferson et al., 2014). A group of approximately 50 individuals was encountered off San Diego in May 2015 and included an individual photo identified previously off Ensenada, Mexico (Kendall-Bar et al., 2016).

4.1.29.3 Population Trends

For Hawaiian waters, the variability in the documented abundance between the 2002 and 2010 surveys precludes an assessment of the population trend for short-finned pilot whales in Hawaii (Carretta et al., 2017).

Pilot whales appeared to have returned to California waters as evidenced by an increase in sighting records, as well as incidental fishery bycatches (Barlow & Forney, 2007; Barlow, 2016; Douglas et al., 2014a). Because these changes likely reflect a change in distribution based on a changing environment rather than a change in the population, there can be no assessment of the current population trend for short-finned pilot whales in California (Carretta et al., 2017).

4.1.30 SPINNER DOLPHIN (*STENELLA LONGIROSTRIS*)

Four well differentiated geographical forms of spinner dolphins have been described as separate subspecies but only *Stenella longirostris* (Gray's spinner dolphin) is present in the HSTT Study Area.

4.1.30.1 Status and Management

The spinner dolphin is protected under the MMPA and the species is not listed under the ESA. The eastern spinner dolphin (*Stenella longirostris orientalis*) is listed as depleted under the MMPA. Hawaiian spinner dolphins (considered a form of Gray's or pantropical spinner dolphin, *Stenella longirostris longirostris*) are considered as separate stocks from those involved in the tuna purse-seine fishery in the eastern tropical Pacific (Dizon et al., 1994). Under the MMPA, there are six stocks found within the U.S. Exclusive Economic Zone of the Hawaiian Islands: (1) Hawaii Island, (2) Oahu/4-Islands, (3) Kauai/Niihau, (4) Pearl & Hermes Reef, (5) Kure/Midway, and (6) Hawaii Pelagic, including animals found both within

the Hawaiian Islands Exclusive Economic Zone (outside of island-associated boundaries) and in adjacent international waters (Carretta et al., 2013a).

4.1.30.2 Habitat and Geographic Range

Spinner dolphins occur in both oceanic and coastal environments and seasonal movement patterns for this species have not been documented. Spinner dolphins are pantropical, ranging through oceanic tropical and subtropical zones in both hemispheres (Jefferson et al., 2015). Based on an analysis of individual spinner dolphin movements in Hawaii, no spinner dolphins from the island associated stocks have been found farther than 10 NM from shore and few individuals move long distances (from one main Hawaiian Island to another) (Hill et al., 2011). Open ocean populations, such as the Hawaii Pelagic stock or those animals in the eastern tropical Pacific, often are found in waters with a shallow thermocline (rapid temperature difference with depth) (Au & Perryman, 1985; Perrin, 2008c; Reilly, 1990). The thermocline concentrates open sea organisms in and above it, which spinner dolphins feed on. In the eastern tropical Pacific, spinner dolphins are associated with tropical surface waters typified by extensive stable thermocline ridging and relatively little annual variation in surface temperature (Au & Perryman, 1985; Perrin, 2008c).

In the Hawaiian Islands, spinner dolphins occur along the leeward coasts of all the major islands and around several of the atolls northwest of the main Hawaiian Islands. Spinner dolphins occur year-round throughout the Hawaiian Islands, with primary occurrence from the shore to the 4,000 m depth. This takes into account nearshore resting habitat and offshore feeding areas. Spinner dolphins are expected to occur in shallow water resting areas (about 50 m deep or less) throughout the middle of the day, moving into deep waters offshore during the night to feed (Heenehan et al., 2016; Heenehan et al., 2017; Norris & Dohl, 1980). Some of these resting areas are in proximity to bathymetric features that result in localized concentration of spinner dolphin prey. For example, there is an escarpment off Hawaii Island's Keahole Point that produces a locally enriched area that spinner dolphins exploit during nightly foraging trips from the nearby Makeko Bay (Heenehan et al., 2017; Norris & Dohl, 1980). Primary resting areas are along the west side of Hawaii, including Makako Bay, Honokohau Bay, Kailua Bay, Kealakekua Bay, Honaunau Bay, and Kauhako Bay, and off Kahena on the southeast side of the island (Heenehan et al., 2016; Heenehan et al., 2017; Norris & Dohl, 1980; Ostman-Lind et al., 2004; Tyne et al., 2015; Tyne et al., 2017). Along the Waianae coast of Oahu, Hawaii, spinner dolphins rest along Makua Beach, Kahe Point, and Pokai Bay during the day (Lammers, 2004). Kilauea Bay on Kauai is also a popular resting areas for Hawaiian spinner dolphins (U.S. Department of the Navy, 2006). Monitoring for the Rim of the Pacific Exercise in 2006 resulted in daily sightings of spinner dolphins within the offshore area of Kekaha Beach, Kauai, near the Pacific Missile Range Facility (U.S. Department of the Navy, 2006). Spinner dolphins have been observed during Navy monitoring surveys at Kaula Island in 2000, 2003, and 2009-2011 (Richie et al., 2012). Although sightings have been recorded around the mouth of Pearl Harbor, Hawaii, spinner dolphin occurrence is rare there (Lammers, 2004; Richie et al., 2016). Occurrence patterns are assumed to be the same throughout the year. Habitat-based models developed from systematic ship survey data collected in the central North Pacific show the strong island association of spinner dolphins (Becker et al., 2012b; Forney et al., 2015), consistent with previously documented distribution patterns (Barlow, 2006).

Spinner dolphins are not present in the Southern California portion of the HSTT Study Area.

4.1.30.3 Population Trends

For spinner dolphins in Hawaii, differences in survey methodologies or insufficient data have precluded an assessment of any population trend for any of the 6 identified stocks (Carretta et al., 2017).

4.1.31 STRIPED DOLPHIN (*STENELLA COERULEOALBA*)

4.1.31.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. In the eastern north Pacific, NMFS identifies two striped dolphin management stocks within the U.S. Exclusive Economic Zone: the Hawaiian stock and the California, Oregon, and Washington stock (Carretta et al., 2017).

4.1.31.2 Habitat and Geographic Range

Although primarily a warm-water species, the range of the striped dolphin extends higher into temperate regions than those of any other species in the genus *Stenella*. Striped dolphins are generally restricted to oceanic regions and are seen close to shore only where deep water approaches the coast. In some areas (e.g., the eastern tropical Pacific), they are mostly associated with convergence zones and regions of upwelling (Au & Perryman, 1985; Reilly, 1990). The northern limits are the Sea of Japan, Hokkaido, Washington State, and along roughly 40° N across the western and central Pacific (Reeves et al., 2002b). In the eastern tropical Pacific, striped dolphins inhabit areas with large seasonal changes in surface temperature and thermocline depth, as well as seasonal upwelling (Au & Perryman, 1985; Reilly, 1990). In some areas, this species appears to avoid waters with sea temperatures less than 68°F (20°C) (Van Waerebeek et al., 1998).

The striped dolphin regularly occurs around the Hawaiian Islands. Two comprehensive shipboard surveys of the Hawaiian U.S. Exclusive Economic Zone resulted in 15 sightings of striped dolphins in 2002 (Barlow, 2006) and 25 sightings in 2010 (Bradford et al., 2017). Resulting density estimates from these surveys suggest that they are one of the most abundant species in the Hawaiian Exclusive Economic Zone. Based on sighting records, this species occurs primarily seaward of the 1,000-m depth contour. Striped dolphins are occasionally sighted closer to shore in Hawaii, so an area of secondary occurrence is expected from a depth range of 100 to 1,000 m. Occurrence patterns are assumed to be the same throughout the year (Mobley et al., 2000). Habitat-based models developed from systematic ship survey data collected in the central North Pacific show more uniform striped dolphin densities throughout the Hawaiian Exclusive Economic Zone, consistent with this species' known occurrence in deep waters (Becker et al., 2012b; Forney et al., 2015).

Based on sighting records, striped dolphins appear to have a continuous distribution in offshore waters from California to Mexico (Mangels & Gerrodette, 1994). The striped dolphin also occurs far offshore, in waters affected by the warm Davidson Current as it flows northward (Archer, 2009; Jefferson et al., 2008). During ship surveys conducted off the U.S. west coast in the summer and fall from 1991 to 2005, striped dolphins were sighted primarily from 100 to 300 NM offshore of the California coast (Barlow & Forney, 2007). Striped dolphin encounters increase in deep, relatively warmer waters off the U.S. west coast (Becker et al., 2012a; Becker et al., 2016; Henderson et al., 2014a), and their abudance decreases north of about 42°N (Barlow et al., 2009; Becker et al., 2012a; Becker et al., 2016; Forney et al., 2012). There were only three striped dolphin encounters during 16 ship surveys off southern California from 2004 to 2008 (Douglas et al., 2014b) and they were not detected during 15 aerial surveys conducted in the Southern California Range Complex from 2008 through 2012 (Smultea & Jefferson, 2014).

4.1.31.3 Population Trends

For the Hawaiian stock of striped dolphin, the large abundance difference between the 2002 and 2010 survey-based estimates and the overlapping confidence intervals preclude assessment of population trends with the available data (Carretta et al., 2017).

For the California, Oregon, and Washington stock of striped dolphins, there is currently no evidence of a trend in abundance for this stock (Carretta et al., 2017).

4.1.32 DALL'S PORPOISE (*PHOCOENOIDES DALLI*)

4.1.32.1 Status and Management

This species is protected under the MMPA and is not listed under the ESA. Dall's porpoise is managed by NMFS in United States Pacific waters as two stocks: (1) a California, Oregon, and Washington stock and (2) an Alaskan stock (Allen & Angliss, 2010; Carretta et al., 2010).

4.1.32.2 Habitat and Geographic Range

Dall's porpoise is one of the most common odontocete species in north Pacific waters (Calambokidis & Barlow, 2004; Ferrero & Walker, 1999; Houck & Jefferson, 1999; Jefferson, 1991; Jefferson et al., 2008; Williams & Thomas, 2007; Zagzebski et al., 2006). Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al., 1993). However, the species is only common between 32° N and 62° N in the eastern North Pacific (Houck & Jefferson, 1999; Morejohn, 1979). It is typically found in waters at temperatures less than 63° F (17° C) with depths of more than 180 m (Houck & Jefferson, 1999; Reeves et al., 2002b).

Dall's porpoises are not present in the Hawaii portion of the HSTT Study Area.

Dall's porpoise distribution off the U.S. west coast is highly variable between years, most likely due to changes in oceanographic conditions (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Forney & Barlow, 1998; Forney et al., 2012). North-south movements in California, Oregon, and Washington have been observed, with Dall's porpoise shifting their distribution southward during cooler-water periods on both interannual and seasonal time scales (Forney & Barlow, 1998). Based on habitat models developed using 1991–2009 survey data collected during summer and fall, Becker et al. (2016) found that encounters of Dall's porpoise increased in shelf and slope waters in the Study Area, and encounters decreased substantially in waters warmer than approximately 63°F (17°C). These patterns are consistent with previous habitat modeling efforts using a subset of the same data (Barlow et al., 2009; Becker et al., 2010; Becker et al., 2012b; Becker et al., 2014; Forney et al., 2012; Henderson et al., 2014a).

During ship surveys conducted quarterly off southern California from 2004 to 2008, Dall's porpoise was encountered year-round, with highest encounters during the cold-water months (Douglas et al., 2014b). There were only five Dall's porpoise sightings during 18 aerial surveys conducted year-round in the Southern California Range Complex from 2008 to 2013 (Jefferson et al., 2014).

4.1.32.3 Population Trends

No data are available regarding population trends for the stock of Dall's porpoises in California, Oregon and Washington (Carretta et al., 2015). Examination of sighting and stranding data from the 1950s

through 2012 suggest that the relative occurrence of this species in the Southern California Bight has not changed substantially over this time period (Smultea & Jefferson, 2014).

4.1.33 Harbor Seal (*Phoca vitulina*)

4.1.33.1 Status and Management

The harbor seal is protected under the MMPA and is not listed under the ESA. Harbor seals are distributed in temperate to cold water regions in the north Pacific. The Society of Marine Mammalogy's Committee on Taxonomy (2016) has determined that all harbor seals in the north Pacific should be recognized as a single subspecies (*Phoca vitulina richardii*) until the subspecies limits of various populations are better known. There are 17 stocks of harbor seal along the U.S. west coast (Carretta et al., 2017; Muto & Angliss, 2016); there is a single California stock occurring within the Southern California portion of the HSTT Study Area.

4.1.33.2 Habitat and Geographic Range

The harbor seal is one of the most widely-distributed seals, found in nearly all temperate coastal waters of the northern hemisphere (Jefferson et al., 2008). Harbor seals are generally not present in the open ocean. Harbor seals are not present in the Hawaii portion of the HSTT Study Area.

Harbor seals, while primarily aquatic, also use the coastal terrestrial environment, where they haul out of the water periodically. Harbor seals are a coastal species, rarely found more than 20 km from shore, and frequently occupy bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Harbor seals are not considered migratory (Burns, 2008; Jefferson et al., 2008).

Ideal harbor seal habitat includes suitable haulout sites, shelter from high surf during the breeding periods, and sufficient food near haulout sites to sustain the population throughout the year (Bjorge, 2002). Haulout sites vary, but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, estuaries, and even peat banks in salt marshes (Burns, 2008; Gilbert & Guldager, 1998; Prescott, 1982; Schneider & Payne, 1983; Wilson, 1978).

Small numbers of harbor seals are found hauled out on coastal and island sites and forage in the nearshore waters of the Southern California Range Complex, but are found in only moderate numbers compared to sea lions and elephant seals. In California, approximately 400 to 600 harbor seal haulout sites are widely distributed along the mainland and on offshore islands of the state (Lowry et al., 2008). The harbor seal haul-out sites in the San Diego area include mainland beaches and all of the Channel Islands, including Santa Barbara, Santa Catalina, and San Nicolas Islands (Lowry et al., 2008). There were for instance 1,367 harbor seals counted in the Channel Islands during aerial surveys in July 2015 (Lowry et al., 2017). Individuals have also been observed hauled out at La Jolla Cove, and within the channel of San Diego Bay at Ballast Point and Navy Base Point Loma. Monitoring during a pier replacement project in at Point Loma (October 2014–April 2015) encountered a mean number of three harbor seals hauled out and 2.00 to 2.48 per day in the water (U.S. Department of the Navy, 2015b). A total of 15 harbor seals were sighted off the coast during 18 aerial surveys conducted between 2008 and 2013 in the Southern California portion of the HSTT Study Area (Jefferson et al., 2014). There were no harbor seals detected in the 17 days of surveys (between October 2013 and September 2014) nearshore off the Silver Strand Training Complex and San Diego Bay (Graham & Saunders, 2015).

4.1.33.3 Population Trends

The most recent (2011) survey of California harbor seal rookeries resulted in the highest recorded pup count since 1975 (Carretta et al., 2015). In the short term, this trend may be affected by the pinniped Unusual Mortality Event that has been ongoing on the U.S. west coast since 2013.

4.1.34 HAWAIIAN MONK SEAL (*NEOMONACHUS SCHAUINSLANDI*)

4.1.34.1 Status and Management

The Hawaiian monk seal was listed as endangered under the ESA in 1976 (National Marine Fisheries Service, 1976) and is listed as depleted under the MMPA. The species is considered a high priority for recovery, based on the high magnitude of threats, the high recovery potential, and the potential for economic conflicts while implementing recovery actions (National Marine Fisheries Service, 2007a, 2011c, 2016e). The approximate area encompassed by the northwestern Hawaiian Islands was designated as the Papahanaumokuakea National Marine Monument in 2006, in part to protect the habitat of the Hawaiian monk seal. Hawaiian monk seals are managed as a single stock. There are six main reproductive subpopulations at: French Frigate Shoals, Laysan Island, Lisianski Island, Pearl and Hermes Reef, Midway Island, and Kure Atoll in the northwestern Hawaiian Islands.

A recovery plan for the Hawaiian monk seal was completed in 1983 and was revised in 2007 (National Marine Fisheries Service, 2007a, 2011c, 2016e). Due to the proximity of the Hawaiian monk seal to human development, commerce, recreation, and culture, the 2007 revised Recovery Plan included a recommendation to develop management specifically addressing issues in the main Hawaiian Islands (National Marine Fisheries Service, 2007a). In response to that recommendation, a “Main Hawaiian Islands Monk Seal Management Plan” was developed (National Marine Fisheries Service, 2016e).

Critical habitat for Hawaiian monk seals was designated August 21, 2015 (National Oceanic and Atmospheric Administration, 2015a) (Figure 4-1). The essential features of the critical habitat were identified as: (1) adjacent terrestrial and aquatic areas with characteristics preferred by monk seals for pupping and nursing; (2) shallow, sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing; (3) marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging; (4) areas with low levels of anthropogenic disturbance; (5) marine areas with adequate prey quantity and quality; and (6) significant areas used by monk seals for hauling out, resting, or molting (National Oceanic and Atmospheric Administration, 2015a).

Section 4(a)(3) of the ESA precludes military land from a Critical Habitat designation, where that land is covered by an Integrated Natural Resource Management Plan if the Secretary of Commerce has found that plan will benefit the listed species (National Oceanic and Atmospheric Administration, 2015c). National Oceanic and Atmospheric Administration (2015c) determined that the Integrated Natural Resource Management Plans for the Pacific Missile Range Facility, Marine Corps Base Hawaii, and the Joint Base Pearl Harbor Hickam each confer conservation benefits to the Hawaiian monk seal and its habitat, and therefore the areas subject to these resource management plans were excluded from designation as Hawaiian monk seal critical habitat. Specifically, the areas determined to be ineligible for designation of critical habitat for the Pacific Missile Range Facility are the shoreline and waters off the installation on Kauai, the coastal land area/shelf/ledge of Kaula Island, and the coastal and marine areas out to 10 m in depth around the island of Niihau that are leased for naval training and testing activities.

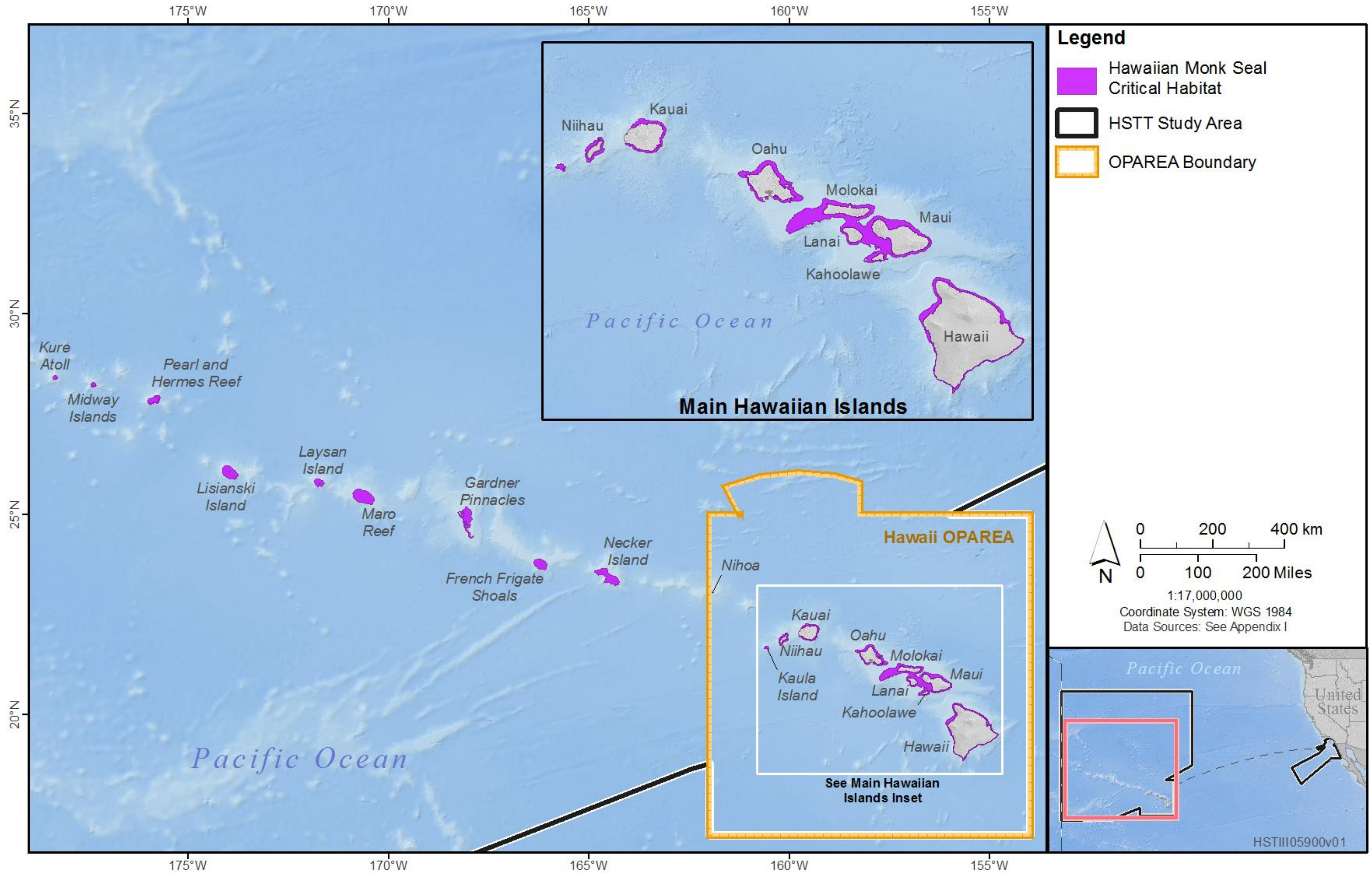

Figure 4-1: Hawaiian Monk Seal Critical Habitat

On Oahu at Marine Corps Base Hawaii on the Mokapu Peninsula, ineligible areas are the 500-yard buffer zone in marine waters surrounding the Marine Corps Base. Ineligible areas for Joint Base Pearl Harbor Hickam are beach or nearshore areas of Oahu in a 500-yard buffer zone in marine waters surrounding Puuloa Training Facility on the Ewa coastal plain, Nimitz Beach, White Plains Beach, the Naval Defensive Sea Area, the Barbers Point Underwater Range, and the Ewa Training Minefield.

These lands and areas are managed by the military and have Integrated Natural Resources Management Plans that were reviewed in accordance with Section 4(a)(3)(B)(i) of the ESA. As detailed in the Hawaiian monk seal critical habitat final rule (National Oceanic and Atmospheric Administration, 2015a), these military areas were not designated as critical habitat because they either lack the features that are essential to monk seal conservation, or they were ineligible for designation under Section 4(a)(3) of the ESA.

The Pacific Island Regional Office of NMFS has the lead responsibility for the recovery of Hawaiian monk seals under the ESA and the MMPA. Since the early 1980s, NMFS has routinely applied flipper tags to weaned pups in the northwestern Hawaiian Islands (Antonelis et al., 2006). NMFS performed capture and release programs through the Head Start Program between 1981 and 1991, “to enhance the survival of young females and thereby increase their subsequent recruitment into the adult female population.” From 1984 to 1995, under NMFS’s Rehabilitation Project, undersized, weaned female pups from French Frigate Shoals and, in some cases, undersized juvenile females, were brought into captivity for 8 to 10 months on Oahu to increase their weight. They were then released into the wild at either Kure Atoll or Midway Islands, where they had a higher probability of survival (Antonelis et al., 2006). Because some males were injuring female seals, in July and August of 1994, 21 adult male Hawaiian monk seals that were known aggressors or that behaved like aggressors were relocated from Laysan Island to the main Hawaiian Islands (National Marine Fisheries Service, 2009b). NMFS relocated three female monk seals (a juvenile in 1981, a pup in 1991, and an adult in 2009) from the main Hawaiian Islands to the northwestern Hawaiian Islands (National Marine Fisheries Service, 2009b).

The State of Hawaii also has important responsibilities for monk seal conservation and recovery. It owns Kure Atoll and has jurisdiction over waters between the reserve boundary and 3 NM around all emergent lands in the northwestern Hawaiian Islands (except Midway) (Marine Mammal Commission, 2003). In March 2007, the State of Hawaii put new regulations into place to restrict the use of lay nets on Oahu, Molokai, Lanai, Kauai, and Niihau and prohibited lay net use in state waters around the entire island of Maui and certain areas on Oahu (National Marine Fisheries Service, 2010c). In 2008, in hopes of raising awareness about the plight of the species, Hawaii’s Lieutenant Governor signed into law legislation that established the Hawaiian monk seal as the official state mammal.

When seals are reported on beaches in the main islands, NMFS works with state and local agencies to cordon off sections of beach around the seals. NMFS also relies on volunteer groups to observe seals and educate the public about their endangered status and protection measures. On Oahu, the Hawaiian Monk Seal Response Team Oahu is a team of over 50 volunteers who routinely assist National Oceanic and Atmospheric Administration Fisheries Pacific Island Regional Office and the Pacific Island Fisheries Science Center in monk seal response issues. Monk seal response programs also exist on Kauai, Maui and the Big Island, with some reporting from Molokai and Lanai (National Marine Fisheries Service, 2010c).

4.1.34.2 Habitat and Geographic Range

Hawaiian monk seals are generally only present in the main Hawaiian Islands and Northwest Hawaiian Islands, but sightings have been reported at Johnston Atoll, Wake Island, and Palmyra Atoll (south of the Hawaiian Island chain; (Carretta et al., 2010; Gilmartin & Forcada, 2009; Jefferson et al., 2015; National Marine Fisheries Service, 2009b, 2010b). The six main breeding sites are in the northwestern Hawaiian Islands: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. Smaller breeding sites are on Necker Island and Nihoa Island, and monk seals have been observed at Gardner Pinnacles and Maro Reef. There is a small breeding population of monk seals found throughout the main Hawaiian Islands and births have been documented on most of the major islands, especially Kauai and Niihau (Gilmartin & Forcada, 2009; National Marine Fisheries Service, 2007a, 2010b). Based on one study, on average, 10 to 15 percent of the monk seals migrate among the northwestern Hawaiian Islands and the main Hawaiian Islands (Carretta et al., 2010). Another source suggests that approximately 35 percent of the main Hawaiian Island seals travel between islands throughout the year (Littnan, 2011). Greater than expected movement between sites within the main Hawaiian Islands and the northwestern Hawaiian Islands (Johanos et al., 2014), has allowed for genetic conductivity between Hawaiian monk seal subpopulations (Schultz et al., 2011).

When hauled out, Hawaiian monk seals seem to prefer beaches of sand, coral rubble, and rocky terraces (Baker et al., 2006; Jefferson et al., 2015). Consistent with ten previous detections of monk seals at Kaula Island, in 2012 there were three individual monk seals were observed hauled out on the rock ledge on the NW side of the island (Richie et al., 2012). Aerial surveys of Kaula Island from April 2013 through March 2016 continued to document monk seals routinely hauled out on the rocky ledges at the edge of the island, numbering between five and 11 monk seals seen on each of the six surveys (Normandeau Associates & APEM, 2013a, 2013b, 2014, 2015a, 2015b, 2016).

In the Main Hawaiian Islands, monk seals are generally solitary and have no established rookeries unlike pinnipeds in Southern California. Hawaiian monk seals do, however, routinely haul out for molting and pupping in locations including at the Navy's Pacific Missile Range Facility, Pearl Harbor, and other military lands. When foraging, monk seals spend most of their time in nearshore, shallow marine habitats, but can rapidly cover large areas in search of food and may travel hundreds of miles in a few days (D'Amico, 2013; Littnan, 2011; Stewart et al., 2006; Wilson et al., 2012).

From 1996-2002 and in an effort to better understand the range of foraging monk seals, Stewart et al. (2006) used satellite-linked radio transmitters to document the movements of 147 Hawaiian monk seals from all six northwestern Hawaiian Islands breeding colonies. Foraging patterns were complex and varied among colonies by season, age and sex, but in general monk seals were found to forage extensively within the atoll barrier reefs and on the leeward slopes of reefs and islands at all colony sites. They also ranged away from these sites along the Hawaiian Islands submarine ridge to most nearby seamounts and submerged reefs and banks (Stewart et al., 2006).

Between February 2010 and July 2011, 12 data tags on monk seals in the main Hawaiian Islands were successfully deployed, retrieved, and analyzed (D'Amico, 2013; Littnan, 2011; Stewart et al., 2006; Wilson et al., 2012). The average foraging trip was approximately 30 km in distance, almost 19 hours in duration, and most seals remained within the 600 m depth contour. Although most trips were less than 50 km two seals made at least one long pelagic foraging trip during the deployment period (Littnan, 2011). An adult male tagged on Oahu traveled over 3,000 km on a trip which lasted 36 days and a sub-adult female tagged on Kauai traveled 300 km on a trip that lasted almost 4 days. Approximately 54

percent of the seals made regular trips between two or more of the islands, while the remainder showed fidelity to one island (Littnan, 2011).

Hawaiian monk seals are not present in the Southern California portion of the HSTT Study Area.

4.1.34.3 Population Trends

Population dynamics at the different locations in the northwestern Hawaiian Islands and the main Hawaiian Islands have varied considerably (Antonelis et al., 2006). Monk seal abundance trends appear affected by the quality of local environmental conditions (Schmelzer, 2000), and limited prey availability may be restricting the recovery of the northwestern Hawaiian Islands monk seals (Baker, 2008; Iverson et al., 2011; Lowry et al., 2011). In 2013, there were an estimated minimum of 179 individuals in the main Hawaiian Islands and the total population based on those counted in the Northwest Hawaiian Islands is estimated in the Pacific Stock Assessment Report to be 909 individuals (Carretta et al., 2017). More recent information presented at the July 2017 Hawaiian Monk Seal Recovery Team meeting was that there are believed to be approximately 1,400 individuals currently in the population (Amlin, 2017).

The overall population trend from 2004 through 2013 was a steady decline, with the total number of Hawaiian monk seals decreasing by 3.4 percent per year (Carretta et al., 2017). While the decline has been driven by the population segment in the northwestern Hawaiian Islands, the number of documented sightings and annual births in the main Hawaiian Islands has increased since the mid-1990s (Baker, 2004; Baker et al., 2016). In the main Hawaiian Islands, the estimated population growth rate is 6.5 percent per year (Baker et al., 2011; Carretta et al., 2017). If those trends continue, abundances in the northwestern Hawaiian Islands and main Hawaiian Islands will equalize by the year 2020 (Littnan, 2011). Range-wide abundance data from 2013 through 2015 and the lack of evidence for further decline in the abundance may indicate the range-wide declining trend in monk seal abundance has ended (Baker et al., 2016).

4.1.35 NORTHERN ELEPHANT SEAL (*MIROUNGA ANGUSTIROSTRIS*)

4.1.35.1 Status and Management

The northern elephant seal is protected under the MMPA and is not listed under the ESA. The northern elephant seal population has recovered dramatically after being reduced to perhaps no more than 10 to 100 animals surviving in Mexico in the 1890s (Carretta et al., 2010; Hoelzel, 1999; Stewart et al., 1994). Movement and some genetic interchange occur among rookeries, but most elephant seals return to the rookeries where they were born to breed and thus may have limited genetic differentiation (Carretta et al., 2010). There are two distinct populations of northern elephant seals: one that breeds in Baja, Mexico, and a population that breeds in California. NMFS stock assessment report considers northern elephant seals in the Study Area to be from the California Breeding Stock, although elephant seals from Baja Mexico frequently migrate north through the Southern California portion of the HSTT Study Area (Aurioles-Gamboa & Camacho-Rios, 2007).

4.1.35.2 Habitat and Geographic Range

Northern elephant seals are found in both coastal and deep waters of the eastern and central north Pacific. Elephant seals spend more than 80 percent of their annual cycle at sea, making long migrations to offshore foraging areas and feeding intensively to build up the blubber stores required to support them during breeding and molting haulouts (Hindell & Perrin, 2009; Le Boeuf & Laws, 1994; Worthy et al., 1992). Breeding and pupping take place on offshore islands and mainland rookeries (Carretta et al.,

2010; Le Boeuf & Laws, 1994). Small colonies of northern elephant seals breed and haul-out on Santa Barbara Island and San Clemente Island with large colonies on San Nicolas and San Miguel Islands (Stewart et al., 1993; Stewart et al., 1994). Aerial survey that included all the Channel Islands in July 2015 found the majority (approximately 61%) of elephant seals at San Miguel Island, approximately 21% at San Nicolas Island, and 18% at Santa Rosa Island (Lowry et al., 2017). Elephant seals use these islands as rookeries from late December to February, and to molt from April to July. Northern elephant seals spend little time nearshore, and migrate through offshore waters four times a year as they travel to and from breeding/pupping and molting areas on various islands and mainland sites along the Mexico and California coasts.

With most of their prey found in open oceans, northern elephant seal juveniles and females are often found in deepwater zones while males also engage in benthic foraging and travel as far north as seamounts in the Gulf of Alaska (Le Boeuf et al., 1996; Le Boeuf et al., 2000; Robinson et al., 2012; Simmons et al., 2007; Simmons et al., 2010; Stewart & DeLong, 1995).

There are records of three northern elephant seals being present in the Hawaiian Islands, indicating that movements beyond their normal range do occur, but are very rare. A female, an immature male, and mature male were sighted on Midway Island in the northwestern Hawaiian Islands in 1978 (Tomich, 1986). On January 2, 2002, a juvenile male elephant seal was discovered on Molokai and reported to be the second confirmed sighting in the Main Hawaiian Islands since 2001 (National Marine Fisheries Service, 2006). This same elephant seal was next encountered on January 11, 2002 on the Kona coast of Hawaii at Kawaihae Beach and later at the Kona Village Resort where it was captured and returned to California by NMFS (Fujimori, 2002). These occurrences in the Hawaiian Islands are considered extralimital and northern elephant seals are not expected to be present in Hawaii portion of the HSTT Study Area.

Northern elephant seals are found in both coastal areas and deeper waters off Southern California (Carretta et al., 2010; Jefferson et al., 2008; Robinson et al., 2012). The foraging range of northern elephant seals extends thousands of kilometers offshore from the breeding range into the central North Pacific Transition Zone well to the north of Hawaii; however, their range is not considered to be continuous across the Pacific (Simmons et al., 2010; Stewart & Huber, 1993). Adult males and females segregate while foraging and migrating (Simmons et al., 2010; Stewart & DeLong, 1995; Stewart, 1997). Adult females mostly range west to about 173° W, between the latitudes of 40° N and 45° N, whereas adult males range farther north into the Gulf of Alaska and along the Aleutian Islands to between 47° N and 58° N (Le Boeuf et al., 2000; Robinson et al., 2012; Stewart et al., 1993; Stewart & DeLong, 1995). Adults stay offshore during migration, while juveniles are often seen along the coasts of Oregon, Washington, and British Columbia (Le Boeuf et al., 1996; Stewart & Huber, 1993). The most far-ranging individual appeared on Nijima Island off the Pacific coast of Japan in 1989 (Kiyota et al., 1992). This demonstrates the great distances that these animals are capable of covering.

4.1.35.3 Population Trends

The population in California continues to increase, but the Mexican stock appears to be stable or slowly decreasing (Carretta et al., 2015; Lowry et al., 2014; Stewart & DeLong, 1994). Some evidence indicates that elephant seals may be expanding their pupping range northward, possibly in response to continued population growth (Hodder et al., 1998). Hodder et al. (1998) noted a possible emerging breeding colony at Shell Island off Cape Arago in southern Oregon. Other northern mainland breeding rookeries include Ano Nuevo, Point Reyes and Cape San Martin (Stewart et al., 1994).

4.1.36 California Sea Lion (*Zalophus californianus*)

4.1.36.1 Status and Management

The California sea lion is protected under the MMPA and is not listed under the ESA. The California sea lion is managed by NMFS as the designated U.S. Stock (Carretta et al., 2017).

4.1.36.2 Habitat and Geographic Range

California sea lions are not present in Hawaii. The California sea lion occurs in the eastern north Pacific from Puerto Vallarta, Mexico, through the Gulf of California and north along the west coast of North America to the Gulf of Alaska (Barlow et al., 2008; Jefferson et al., 2008; Maniscalco et al., 2004). Typically, during the summer, California sea lions congregate near rookery islands and specific open-water areas. The primary rookeries off the coast of the United States are on San Nicolas, San Miguel, Santa Barbara, and San Clemente Islands (Carretta et al., 2000; Le Boeuf & Bonnell, 1980; Lowry et al., 1992; Lowry & Forney, 2005). Haulout sites are also found on Santa Catalina Island in the Southern California Bight (Le Boeuf, 2002). This species is prone to invade human-modified coastal sites that provide good hauling substrate, such as marinas, buoys, bait barges, and rip-rap tidal control structures.

California sea lions are the most common marine mammal in San Diego Bay based on monitoring and survey results (Graham & Saunders, 2015; U.S. Department of the Navy, 2015b). There are two “bait” barges near the mouth of San Diego Bay that are resting locations for California sea lions (U.S. Department of the Navy, 2015b). Monitoring (October 2014 to April 2015) during a pier replacement project in at Point Loma found the number of California sea lions averaged approximately 38 sea lions hauled out and 2 to 3 individuals in the water (U.S. Department of the Navy, 2015b).

In the nonbreeding season, beginning in late-summer, adult and subadult males migrate northward along the coast of California to Washington and return south the following spring (Lowry & Forney, 2005). Females and juveniles also disperse somewhat, but tend to stay in the Southern California area although north and west of the Channel Islands (Lowry & Forney, 2005; Melin & DeLong, 2000; Thomas et al., 2009). California sea lions from the west coast of the Baja California peninsula also migrate to Southern California during the fall and winter (Lowry & Forney, 2005) and sea lions from San Clemente Island tend to remain in Southern California (Melin, 2015). There is a general distribution shift northwest in fall and southeast during winter and spring, probably in response to changes in prey availability (Carretta et al., 2010).

California sea lions can be found in California open ocean and coastal waters (Barlow et al., 2008; Jefferson et al., 2008; Lander et al., 2010). California sea lions are usually found in waters over the continental shelf and slope; however, they are also known to occupy locations far offshore in deep, oceanic waters, such as Guadalupe Island, Alijos Rocks off Baja California (Jefferson et al., 2008; Melin et al., 2008; Urrutia & Dziendzielewski, 2012; Zavala-Gonzalez & Mellink, 2000). California sea lions are the most frequently sighted pinnipeds offshore of Southern California during the spring, and peak abundance is during the May through August breeding season (Green et al., 1992; Keiper et al., 2005).

Tagged California sea lions from Monterey Bay and San Nicolas Island, California, demonstrated that adult males can travel more than 450 km from shore during longer foraging bouts (Weise et al., 2006; Weise et al., 2010); however, rehabilitated females and subadults normally stay mostly within 65 km of the coast (Thomas et al., 2009). Most individuals stay within 50 km of the rookery islands during the breeding season (Melin & DeLong, 2000). Females breeding and pupping on the Channel Islands typically

feed over the continental shelf and generally remain within 150 km north and west of the islands (Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008; Melin et al., 2012). Tagging results showed that lactating females foraging along the coast would travel as far north as Monterey Bay and offshore to the 1,000 m depth (Henkel & Harvey, 2008; Kuhn & Costa, 2014; Melin & DeLong, 2000; Melin et al., 2008). During the nonbreeding season, most locations of occurrence are over the slope or offshore; during the breeding season, most locations of occurrence are over the continental shelf (Melin & DeLong, 2000; Melin et al., 2008). Lowry and Forney (2005) estimated that 47 percent of sea lions would potentially be at-sea during the cold seasons.

Adult females alternate between nursing their pup on shore and foraging at sea, spending approximately 67-77 percent of time at sea (Kuhn & Costa, 2014; Melin & DeLong, 2000).

4.1.36.3 Population Trends

The California sea lion is the most abundant pinniped along the California coast. Overall, the California sea lion population is abundant and generally increasing (Carretta et al., 2010; Jefferson et al., 2008).

In spite of the robustness of the overall species population, in Mexican waters in the Gulf of California, the abundance of California sea lions has declined over the last decade (Urrutia & Dziendzielewski, 2012). A time-series data analysis supported the hypothesis that the Gulf of California has four subpopulations of California sea lions, most of which exhibit lower-than-expected growth rates and two of which have high probabilities of extinction within the next 50 years (Ward et al., 2010).

4.1.37 GUADALUPE FUR SEAL (*ARCTOCEPHALUS TOWNSENDI*)

4.1.37.1 Status and Management

The Guadalupe fur seal is listed as threatened under the ESA and depleted under the MMPA. Critical habitat for the Guadalupe fur seal has not been designated given that the only areas that meet the definition for critical habitat are outside of U.S. jurisdiction (National Oceanic and Atmospheric Administration, 1985). Guadalupe fur seals were hunted nearly to extinction during the 1800s. The last NMFS status review of the Guadalupe fur seals was conducted in 1984 but with the recent population growth and increase in distribution NMFS has initiated a new status review (Fahy, 2015). All individuals alive today are recent descendants from one breeding colony at Isla Guadalupe and Isla San Benito off Mexico and are considered a single stock (Carretta et al., 2017; Pablo-Rodriguez et al., 2015).

4.1.37.2 Habitat and Geographic Range

Guadalupe fur seals are not found in the Hawaii portion of the HSTT Study Area.

The Guadalupe fur seal is typically found on shores with abundant large rocks, often at the base of large cliffs. They are also known to inhabit caves, which provide protection and cooler temperatures, especially during the warm breeding season (Belcher & Lee, 2002). Adult males, juveniles, and nonbreeding females may live at sea during some seasons or for part of a season (Reeves et al., 1992). Several observations suggest that this species travels alone or in small groups of fewer than five (Belcher & Lee, 2002; Seagars, 1984).

Before intensive hunting decreased their numbers, Guadalupe fur seals ranged from Monterey Bay, California, to the Revillagigedo Islands, Mexico (Aurioles-Gamboa et al., 2010). Guadalupe fur seals are most common at Guadalupe Island, Mexico, their primary breeding ground (Melin & DeLong, 1999). A

second rookery was found in 1997 at the San Benito Islands off Baja California (Aurioles-Gamboa et al., 2010; Esperon Rodriguez & Gallo Reynoso, 2012; Maravilla-Chavez & Lowry, 1999) and they have been found in La Paz Bay in the Southern Gulf of California (Elorriaga-Verplancken et al., 2016a). Adult and juvenile males have been observed at San Miguel Island, California, since the mid-1960s, and in the late 1990s, a pup was born on the island (Melin & DeLong, 1999). Sightings have also occurred at Santa Barbara, San Nicolas, and San Clemente Islands (Stewart, 1981). Documentation of apparently healthy Guadalupe fur seals in offshore waters of Washington and British Columbia, the increased number of strandings in the Pacific Northwest, the increase in ocean temperature of the Northeastern Pacific, and their increasing population suggest that Guadalupe fur seals may be reinhabiting the extent of their previous range (Etnier, 2002; Lamborne et al., 2013). Satellite tracking data demonstrating movements into the offshore waters of the Pacific Northwest also support this suggestion (Norris et al., 2015; Norris, 2017).

Guadalupe fur seals can be found more commonly in deeper waters of the open ocean and less frequently in the coastal waters within the Southern California portion of the HSTT Study Area (Hanni et al., 1997; Jefferson et al., 2015, Norris 2017, pers.com). The offshore waters at the southern edge of the Southern California portion of the HSTT Study Area is within a few nautical miles of Guadalupe Island. Recent tagging data has shown Guadalupe fur seals to be extremely pelagic while foraging in the North Pacific such that many individuals occur seaward of the 2,000 m contour during transits of the offshore portion of the HSTT Study Area (Norris 2017, pers.com).

The at-sea movements of Guadalupe fur seals at sea are generally unknown although there are limited data from females and rehabilitated animals (Gallo-Reynoso et al., 2008; Norris et al., 2015). As of 2017, animals from Guadalupe Island affixed with data recording tags (n=39) have included adult females, juvenile/sub-adult males and females, and weaned pups/yearlings and there have been satellite tags (n=26) placed on rehabilitated pups/yearlings that had stranded in California that were released from central California (Gallo-Reynoso et al., 2008; Norris et al., 2015). Data from animals leaving Guadalupe Island indicate that Guadalupe fur seals primarily use habitats offshore of the continental shelf between 50-300 km from the U.S. west coast with approximately one quarter of the population foraging farther out and up to 700 km offshore (Norris 2017, pers. com). Females with pups are generally restricted to rookery areas because they must return to nurse their pups (Gallo-Reynoso et al., 2008). Satellite tags have documented the movement of females without pups being at least as far as 1,300 km north of Guadalupe Island (approximately Point Cabrillo in Mediciono County, California). Adult males have not been tagged but typically undertake some form of seasonal movement either after the breeding season or during the winter, when prey availability is reduced (Arnould, 2009). Satellite tagged juvenile males appear to have more variable movement patterns than females, and although most remained within 600 km of Guadalupe Island, only one of ten satellite tagged males traveled north of Point Cabrillo, California (Norris 2017, pers. com).

4.1.37.3 Population Trends

The most recent stock assessment report (Carretta et al., 2017) reflects the population of Guadalupe fur seals from a survey in 2010, which indicated a total estimated population size of approximately 20,000 animals. Although the estimated growth rate over the period between 1955-2010 was approximately 10% annually (Carretta et al., 2017), the ongoing Unusual Mortality Event involving Guadalupe fur seals (National Marine Fisheries Service, 2015e; National Oceanic and Atmospheric Administration, 2017) is likely to have impacted that trend (Elorriaga-Verplancken et al., 2016a; Elorriaga-Verplancken et al., 2016b).

4.1.38 NORTHERN FUR SEAL (*CALLORHINUS URSINUS*)

4.1.38.1 Status and Management

Two stocks of northern fur seals (*Callorhinus ursinus*) are recognized in United States waters: an eastern Pacific stock and a California stock (Carretta et al., 2017). The California stock, which is present in the Southern California portion of the HSTT Study Area, is protected under the MMPA, is not considered depleted and is not listed under the ESA (Carretta et al., 2017).

4.1.38.2 Habitat and Geographic Range

Northern fur seals do not normally occur in Hawaiian waters. In July 2012, an adult female northern fur seal was found on the north shore of Oahu in an emaciated condition (Marine Mammal Center, 2012). This was the first known occurrence of a northern fur seal in Hawaii and they are considered extralimital to those waters.

Northern fur seals range throughout the north Pacific along the west coast, from California (32° N) to the Bering Sea, and west to the Okhotsk Sea and Honshu Island, Japan (36° N) (Baird & Hanson, 1997; Carretta et al., 2010; Gentry, 2009; Jefferson et al., 2008; Ream et al., 2005). They are typically found over the edge of the continental shelf and slope (Gentry, 2009; Sterling & Ream, 2004), although two fur seals were tracked over 2,000 km offshore into the central North Pacific Ocean (Ream et al., 2005). Northern fur seals are found throughout their offshore range throughout the year, although seasonal peaks are known to occur. Females and subadult males are often observed off Canada's west coast during winter (Baird & Hanson, 1997).

To the north of the northern boundary for the Southern California portion of the HSTT Study Area, northern fur seal colonies are present at Adams Cove on San Miguel Island and on Castle Rock, an offshore island 1.1 km northwest of San Miguel Island (Baird & Hanson, 1997; Melin et al., 2012; Pyle et al., 2001; Stewart & Huber, 1993). Northern fur seal can also occasionally be present on San Nicolas Island during summer (Baird & Hanson, 1997; Melin et al., 2012; Pyle et al., 2001). Animals from the California stock may remain in or near the area throughout the year but generally move to the North Pacific in waters off Washington, Oregon, and northern California to forage (Carretta et al., 2017; Koski et al., 1998; Melin et al., 2012; Sterling et al., 2014).

Most northern fur seals, excluding those of the California stock, migrate along continental margins from low-latitude winter foraging areas to northern breeding islands (Gentry, 2009; Ragen et al., 1995). They leave the breeding islands in November and concentrate around the continental margins of the north Pacific Ocean in January and February, where they have access to vast, predictable food supplies (Gentry, 2009; Ream et al., 2005). Juveniles have been known to conduct trips between 8 and 29 days in duration, ranging from 171 to 680 km (Sterling & Ream, 2004). Adult female fur seals equipped with radio transmitters have been recorded conducting roundtrip foraging trips of up to 740 km (National Marine Fisheries Service, 2007b; Robson et al., 2004).

4.1.38.3 Population Trends

The abundance of northern fur seals at San Miguel Island, the primary rookery for the California stock, has increased steadily over the past four decades, except for two severe declines associated with El Niño-Southern Oscillation events in 1993 and 1998 (Carretta et al., 2015; DeLong & Stewart, 1991; Melin et al., 2006; Melin et al., 2008; Orr et al., 2012). The San Miguel Island population makes up 96 percent of the California stock of northern fur seals (Carretta et al., 2015).

5 Type of Incidental Taking Authorization Requested

The Navy requests regulations and two Letters of Authorization for the take of marine mammals incidental to proposed activities in the HSTT Study Area for the period from 2018 through 2023: (1) a 5-year LOA for training activities, and (2) a 5-year LOA for testing activities. The term "take," as defined in Section 3 (16 U.S.C. § 1362 (13)) of the Marine Mammal Protection Act (MMPA), means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of "harassment" as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government, consistent with Section 104(c)(3) [16 U.S.C. § 1374(c)(3) of the MMPA]. The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). Military training and testing activities within the HSTT Study Area are composed of military readiness activities as that term is defined in Public Law 107-314 because training and testing activities constitute "training and operations of the Armed Forces that relate to combat" and "adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." For military readiness activities, the relevant definition of harassment is any act that:

- Injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment"); or
- Disturbs or is likely to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behavioral patterns are abandoned or significantly altered ("Level B harassment") [16 U.S.C. § 1362(18)(B)(i) and (ii)].

Although the statutory definition of Level B harassment for military readiness activities requires that the natural behavior patterns of a marine mammal be significantly altered or abandoned, the current state of science for determining those thresholds is somewhat unsettled. Therefore, in its analysis of impacts associated with acoustic sources, the Navy is adopting a conservative approach that overestimates the number of takes by Level B harassment. Many of the responses estimated using the Navy's quantitative analysis are most likely to be moderate severity. Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion. As discussed in Section 6.4.1.6.1.1 (Criteria and Thresholds Used to Estimate Impacts from Sonar and Other Transducers – Behavioral Responses from Sonar and Other Transducers), the behavioral response functions used within the Navy's quantitative analysis were primarily derived from experiments using short-duration sound exposures lasting, in many cases, for less than 30 minutes. If animals exhibited moderate severity reactions for the duration of the exposure or longer, then it was conservatively assumed that the animal experienced a significant behavioral reaction. However, the experiments did not include measurements of costs to animals beyond the immediately observed reactions, and no direct correlations exist between an observed behavioral response and a cost that may result in long-term consequences.

Within the Navy's quantitative analysis, many behavioral reactions are estimated from exposure to sound that may exceed an animal's behavioral threshold for only a single exposure to several minutes. It is likely that many of the estimated behavioral reactions within the Navy's quantitative analysis would not constitute significant behavioral reactions; however, the numbers of significant verses non-significant behavioral reactions are currently impossible to predict. Consequently, there is a high likelihood that significant numbers of marine mammals exposed to acoustic sources are not significantly altering or abandoning their natural behavior patterns. As such, the overall impact of acoustic sources from military readiness activities on marine mammal species and stocks is negligible, i.e. cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stocks through effects on annual rates of recruitment or survival.

The HSTT Draft EIS/ OEIS considered all training and testing activities proposed to occur in the Study Area that have the potential to result in the MMPA defined take of marine mammals. The Navy determined that the following three stressors could result in the incidental taking of marine mammals:

- **Acoustics** (sonar and other transducers; air guns; pile driving)
- **Explosives** (explosive shock wave and sound; explosive fragments)
- Physical Disturbance and Strike (vessel strike)

Acoustic and explosive sources have the potential to result in incidental takes of marine mammals by harassment, injury, or mortality. Vessel strikes have the potential to result in incidental take from direct injury and/or mortality.

The quantitative analysis process used for the HSTT Draft EIS/OEIS and this request for LOAs to estimate potential exposures to marine mammals resulting from acoustic and explosive stressors is detailed in the technical report titled *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d). The Navy Acoustic Effects Model estimates acoustic and explosive effects without taking mitigation into account; therefore, the model overestimates predicted impacts on marine mammals within mitigation zones.

To account for mitigation for marine species, the Navy conservatively quantifies the potential for mitigation to reduce model-estimated permanent threshold shift (PTS) to temporary threshold shift (TTS) for exposures to sonar and other transducers, and reduce model-estimated mortality to injury for exposures to explosives. For additional information on the quantitative analysis process and mitigation measures, refer to Chapter 6 (Take Estimates for Marine Mammals) and Chapter 11 (Mitigation Measures).

5.1 INCIDENTAL TAKE REQUEST FROM ACOUSTIC AND EXPLOSIVE SOURCES

A detailed analysis of effects due to marine mammal exposures to acoustic and explosive sources in the HSTT Study Area from Navy training and testing activities is presented in Chapter 6 (Take Estimates for Marine Mammals). Based on the quantitative analysis of acoustic and explosive sources described in Chapter 6 (Take Estimates for Marine Mammals), Table 5-1 summarizes the Navy's take request from training and testing activities annually (based on the maximum number of activities per 12-month period) and the summation over a 5-year period.

The five-year total impacts may be less than the sum total of each year, given that; not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over the course of a 5-year period.

In summary, over the 5-year LOA period being requested, the Navy's quantitative analysis for acoustic and explosive sources in HSTT estimates 10 total mortalities to specific species (see Section 5.1.1 and 5.1.2 for details), 3,335 Level A exposures, and 12,692,365 Level B exposures.

Table 5-1: Summary of Annual and 5-Year Take Request from Acoustic and Explosive Sources for HSTT Training and Testing Activities

MMPA Category	*Source*	*Annual Authorization Sought*		*5-Year Authorization Sought*	
		Training Activities[1]	*Testing Activities*[2]	*Training Activities*	*Testing Activities*
Mortality	Explosive	2 Species-specific mortalities discussed in 5.1.1	1 Species-specific mortalities discussed in 5.1.2	7 Species-specific mortalities discussed in 5.1.1	3 Species-specific mortalities discussed in 5.1.2
Level A	Acoustic & Explosive	478 Species-specific shown in Table 5-2	234 Species-specific shown in Table 5-3	2,231 Species-specific shown in Table 5-2	1,095 Species-specific shown in Table 5-3
Level B	Acoustic & Explosive	1,707,014 Species-specific shown in Table 5-2	1,061,143 Species-specific shown in Table 5-3	7,619,879 Species-specific shown in Table 5-2	5,072,486 Species-specific shown in Table 5-3

[1] Take estimates for acoustic and explosive sources for training activities are based on the maximum number of activities in a 12-month period.
[2] Take estimates for acoustic and explosive sources for testing activities are based on the maximum number of activities in a 12-month period.

5.1.1 Incidental Take Request from Acoustic and Explosive Sources for Training Activities

Chapter 6 (Take Estimates for Marine Mammals) contains detailed species-specific results of the quantitative analysis of potential exposures to acoustic and explosive sources from training and testing activities within the HSTT Study Area. Table 5-2 summarizes the Navy's take request (exposures which may lead to Level B and Level A harassment) for training activities by species and stock breakout annually (based on the maximum number of activities per 12-month period) and the summation over a 5-year period from the quantitative analysis.

As previously mentioned, the quantitative analysis estimates mortalities to specific species from acoustic and explosive sources in HSTT. Table 5-2 includes estimates for mortality within the summed Level A totals per year and per 5-year period.

The five-year total impacts may be less than the sum total of each year, given that; not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over the course of a 5-year period.

Specifically, over the course of a year, the quantitative analysis estimates mortality of one [1] short-beaked common dolphin and one [1] California sea lion as a result of exposure to explosive training activities. Over the 5-year LOA period being requested, mortality of seven [7] marine mammals in total (three [3] short-beaked common dolphins and four [4] California sea lions) is estimated as a result of exposure to explosive training activities.

Table 5-2: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Training Activities

Species	*Stock*	*Annual*		*5-Year Total***	
		Level B	*Level A*	*Level B*	*Level A*
Suborder Mysticeti (baleen whales)					
Family Balaenopteridae (rorquals)					
Blue whale*	Central North Pacific	34	0	139	0
	Eastern North Pacific	1,155	1	5,036	3
Bryde's whale†	Eastern Tropical Pacific	27	0	118	0
	Hawaiian†	105	0	429	0
Fin whale*	California, Oregon, & Washington	1,245	0	5,482	0
	Hawaiian	33	0	133	0
Humpback whale†	California, Oregon, & Washington†	669	1	2,864	3
	Central North Pacific	5,604	1	23,654	5
Minke whale	California, Oregon, & Washington	649	1	2,920	4
	Hawaiian	3,463	1	13,664	2
Sei whale*	Eastern North Pacific	53	0	236	0
	Hawaiian	118	0	453	0
Family Eschrichtiidae					
Gray whale†	Eastern North Pacific	2,751	5	11,860	19
	Western North Pacific†	4	0	14	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale*	California, Oregon, & Washington	1,397	0	6,257	0
	Hawaiian	1,714	0	7,078	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Hawaiian	13,961	35	57,571	148
Pygmy sperm whale	Hawaiian	5,556	16	22,833	64
Kogia whales	California, Oregon, & Washington	6,012	23	27,366	105
Family Ziphiidae (beaked whales)					
Baird's beaked whale	California, Oregon, & Washington	1,317	0	6,044	0
Blainville's beaked whale	Hawaiian	3,687	0	16,364	0
Cuvier's beaked whale	California, Oregon, & Washington	0	0	0	0
	Hawaiian	1,235	0	5,497	0

Table 5-2: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Training Activities (continued)

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
Longman's beaked whale	Hawaiian	13,010	0	57,172	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	10,715	0	49,516	0
Family Delphinidae (dolphins)					
Bottlenose dolphin	California Coastal	214	0	876	0
	California, Oregon, & Washington Offshore	31,986	2	142,966	9
	Hawaiian Pelagic	2,086	0	9,055	0
	Kauai & Niihau	74	0	356	0
	Oahu	8,186	1	40,918	5
	4-Island	152	0	750	0
	Hawaii	42	0	207	0
False killer whale†	Hawaii Pelagic	701	0	3,005	0
	Main Hawaiian Islands Insular†	405	0	1,915	0
	Northwestern Hawaiian Islands	256	0	1,094	0
Fraser's dolphin	Hawaiian	28,409	1	122,784	3
Killer whale	Eastern North Pacific Offshore	73	0	326	0
	Eastern North Pacific Transient/West Coast Transient	135	0	606	0
	Hawaiian	84	0	352	0
Long-beaked common dolphin	California	128,994	14	559,540	69
Melon-headed whale	Hawaiian Islands	2,335	0	9,705	0
	Kohala Resident	182	0	913	0
Northern right whale dolphin	California, Oregon, & Washington	56,820	8	253,068	40
Pacific white-sided dolphin	California, Oregon, & Washington	43,914	3	194,882	12
Pantropical spotted dolphin	Hawaii Island	2,585	0	12,603	0
	Hawaii Pelagic	6,809	0	29,207	0
	Oahu	4,127	0	20,610	0
	4-Island	260	0	1,295	0
Pygmy killer whale	Hawaiian	5,816	0	24,428	0
	Tropical	471	0	2,105	0

Table 5-2: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Training Activities (continued)

Species	***Stock***	***Annual***		***5-Year Total***	
		Level B	***Level A***	***Level B***	***Level A***
Risso's dolphin	California, Oregon, & Washington	76,276	6	338,560	30
	Hawaiian	6,590	0	28,143	0
Rough-toothed dolphin	Hawaiian	4,292	0	18,506	0
	NSD[1]	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	932,453	47	4,161,283	222
Short-finned pilot whale	California, Oregon, & Washington	990	1	4,492	5
	Hawaiian	8,594	0	37,077	0
Spinner dolphin	Hawaii Island	89	0	433	0
	Hawaii Pelagic	3,138	0	12,826	0
	Kauai & Niihau	310	0	1,387	0
	Oahu & 4-Island	1,493	1	7,445	5
Striped dolphin	California, Oregon, & Washington	119,219	1	550,936	3
	Hawaiian	5,388	0	22,526	0
Family Phocoenidae (porpoises)					
Dall's porpoise	California, Oregon, & Washington	27,278	137	121,236	634
Suborder Pinnipedia					
Family Otariidae (eared seals)					
California sea lion	U.S.	69,543	92	327,136	455
Guadalupe fur seal*	Mexico	518	0	2,386	0
Northern fur seal	California	9,786	0	44,017	0
Family Phocidae (true seals)					
Harbor seal	California	3,119	7	13,636	34
Hawaiian monk seal*	Hawaiian	139	1	662	3
Northern elephant seal	California	38,169	72	170,926	349

* ESA-listed species (all stocks) within the HSTT Study Area

**5-year total impacts may be less than sum total of each year.Not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over course of a 5-year period

†Only designated stocks are ESA-listed

[1]NSD: No stock designation

5.1.2 INCIDENTAL TAKE REQUEST FROM ACOUSTIC AND EXPLOSIVE SOURCES FOR TESTING ACTIVITIES

Table 5-3 summarizes the Navy's take request (exposures which may lead to Level B and Level A harassment) for testing activities by species and stock breakout annually (based on the maximum number of activities per 12-month period) and the summation over a 5-year period from the quantitative analysis. The five-year total impacts may be less than the sum total of each year, given that; not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over the course of a 5-year period.

As previously mentioned, the quantitative analysis estimates mortalities to specific species from acoustic and explosive sources in HSTT. Table 5-3 includes estimates for mortality within the summed Level A totals per year and per 5-year period.

Specifically, over the course of a year, the quantitative analysis estimates mortality of one [1] short-beaked common dolphin as a result of exposure to explosive testing activities. Over the 5-year LOA period being requested, mortality of three [3] short-beaked common dolphins is estimated as a result of exposure to explosive testing activities.

Table 5-3: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Testing Activities

Species	Stock	Annual		5-Year Total**	
		Level B	Level A	Level B	Level A
Suborder Mysticeti (baleen whales)					
Family Balaenopteridae (rorquals)					
Blue whale*	Central North Pacific	14	0	65	0
	Eastern North Pacific	833	0	4,005	0
Bryde's whale†	Eastern Tropical Pacific	14	0	69	0
	Hawaiian†	41	0	194	0
Fin whale*	California, Oregon, & Washington	980	1	4,695	3
	Hawaiian	15	0	74	0
Humpback whale†	California, Oregon, & Washington†	449	0	2,178	0
	Central North Pacific	3,522	2	16,777	10
Minke whale	California, Oregon, & Washington	276	0	1,309	0
	Hawaiian	1,467	1	6,918	4
Sei whale*	Eastern North Pacific	26	0	124	0
	Hawaiian	49	0	229	0
Family Eschrichtiidae					
Gray whale†	Eastern North Pacific	1,920	2	9,277	7
	Western North Pacific†	2	0	11	0
Suborder Odontoceti (toothed whales)					
Family Physeteridae (sperm whale)					
Sperm whale*	California, Oregon, & Washington	1,096	0	5,259	0
	Hawaiian	782	0	3,731	0
Family Kogiidae (sperm whales)					
Dwarf sperm whale	Hawaiian	6,459	29	30,607	140
Pygmy sperm whale	Hawaiian	2,595	13	12,270	60
Kogia whales	California, Oregon, & Washington	3,120	15	14,643	67
Family Ziphiidae (beaked whales)					
Baird's beaked whale	California, Oregon, & Washington	727	0	3,418	0
Blainville's beaked whale	Hawaiian	1,698	0	8,117	0
Cuvier's beaked whale	California, Oregon, & Washington	0	0	0	0
	Hawaiian	561	0	2,675	0

Table 5-3: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Testing Activities (continued)

Species	Stock	Annual		5-Year Total	
		Level B	Level A	Level B	Level A
Longman's beaked whale	Hawaiian	6,223	0	29,746	0
Mesoplodon spp (beaked whale guild)	California, Oregon, & Washington	6,863	0	32,185	0
Family Delphinidae (dolphins)					
Bottlenose dolphin	California Coastal	1,595	0	7,968	0
	California, Oregon, & Washington Offshore	23,436	1	112,410	4
	Hawaiian Pelagic	1,242	0	6,013	0
	Kauai & Niihau	491	0	2,161	0
	Oahu	475	0	2,294	0
	4-Island	207	0	778	0
	Hawaii	38	0	186	0
False killer whale†	Hawaii Pelagic	340	0	1,622	0
	Main Hawaiian Islands Insular†	184	0	892	0
	Northwestern Hawaiian Islands	125	0	594	0
Fraser's dolphin	Hawaiian	12,664	1	60,345	5
Killer whale	Eastern North Pacific Offshore	34	0	166	0
	Eastern North Pacific Transient/West Coast Transient	64	0	309	0
	Hawaiian	40	0	198	0
Long-beaked common dolphin	California	118,278	6	568,020	24
Melon-headed whale	Hawaiian Islands	1,157	0	5,423	0
	Kohala Resident	168	0	795	0
Northern right whale dolphin	California, Oregon, & Washington	41,279	3	198,917	15
Pacific white-sided dolphin	California, Oregon, & Washington	31,424	2	151,000	8
Pantropical spotted dolphin	Hawaii Island	1,409	0	6,791	0
	Hawaii Pelagic	3,640	0	17,615	0
	Oahu	202	0	957	0
	4-Island	458	0	1,734	0

Table 5-3: Species-Specific Take Requests from Modeling Estimates of Acoustic and Explosive Sound Source Effects for All Testing Activities (continued)

Species	***Stock***	***Annual***		***5-Year Total***	
		Level B	***Level A***	***Level B***	***Level A***
Pygmy killer whale	Hawaiian	2,708	0	13,008	0
	Tropical	289	0	1,351	0
Risso's dolphin	California, Oregon, & Washington	49,985	3	240,646	15
	Hawaiian	2,808	0	13,495	0
Rough-toothed dolphin	Hawaiian	2,193	0	10,532	0
	NSD[1]	0	0	0	0
Short-beaked common dolphin	California, Oregon, & Washington	560,120	46	2,673,431	222
Short-finned pilot whale	California, Oregon, & Washington	923	0	4,440	0
	Hawaiian	4,338	0	20,757	0
Spinner dolphin	Hawaii Island	202	0	993	0
	Hawaii Pelagic	1,396	0	6,770	0
	Kauai & Niihau	1,436	0	6,530	0
	Oahu & 4-Island	331	0	1,389	0
Striped dolphin	California, Oregon, & Washington	56,035	2	262,973	10
	Hawaiian	2,396	0	11,546	0
Family Phocoenidae (porpoises)					
Dall's porpoise	California, Oregon, & Washington	17,091	72	81,611	338
Suborder Pinnipedia					
Family Otariidae (eared seals)					
California sea lion	U.S.	48,665	6	237,870	23
Guadalupe fur seal*	Mexico	939	0	4,357	0
Northern fur seal	California	5,505	1	26,168	4
Family Phocidae (true seals)					
Harbor seal	California	2,322	1	11,258	5
Hawaiian monk seal*	Hawaiian	77	0	254	0
Northern elephant seal	California	22,702	27	107,343	131

* ESA-listed species (all stocks) within the HSTT Study Area
**5-year total impacts may be less than sum total of each year.Not all activities occur every year; some activities occur multiple times within a year; and some activities only occur a few times over course of a 5-year period
†Only designated stocks are ESA-listed
[1]NSD: No stock designation

5.2 Incidental Take Request from Vessel Strikes

A detailed analysis of strike data is contained in Section 6.6 (Estimated Take of Marine Mammals by Vessel Strike). Vessel strike to marine mammals is not associated with any specific training or testing activity but rather a limited, sporadic, and incidental result of Navy vessel movement within the Study Area.

Based on the resulting probabilities presented in this analysis, the cumulative low history of Navy vessel strikes from 2009-2016, and the decrease in strike incidents (zero since 2009) by the Navy since introduction of the Marine Species Awareness Training and adaptation of additional mitigation measures since 2009, the Navy does not anticipate vessel strikes to marine mammals within the HSTT Study Area during training and testing activities.

As a cautionary acknowledgment that some probability of ship strike, although low, could occur over a five year authorization, the Navy is electing to request takes from vessel strikes for HSTT. The period from 2009 to 2016 was used as the most appropriate time frame from which to calculate the potential probability of a large whale ship strike from Navy vessels in HSTT over the term of anticipated HSTT permit (2019-2023). 2009 represents the beginning of programmatic permitting within the Atlantic and Pacific; acknowledges advances in Navy marine species awareness training and overall enhanced sensitivity to marine resource issues in general; represents the codification of multiple marine species mitigation measures including specific measures to avoid large whales by 500 yards so long as it is safe for navigation; and finally is more representative of current and reasonably foreseeable marine mammal occurrence in HSTT. In addition, 2009 represents a 10 year horizon, which is consistent with the fact that NMFS doesn't consider information older than eight years old in regional stock assessment reports.

Vessel strike to marine mammals is not associated with any specific training or testing activity but rather a limited, sporadic, accidental, and incidental result of Navy training and testing within the Study Area. Based on the probabilities of whale strikes suggested by an analysis of past strike data and anticipated future training and testing at-sea days described above, the Navy requests authorization for take of no more than three (3) cetaceans, by injury or mortality, resulting from vessel strike incidental to the Navy training and testing activities combined within any portion of the Study Area over the course of the five years of the HSTT regulations.

From unpublished NMFS data, the most commonly struck whales in Hawaii are humpback whales, and the most commonly struck whales in California are gray whales, fin whales, and humpback whales. The majority of these strikes are from non-Navy commercial shipping. For both areas (Hawaii and California), the higher strike rates to these species is largely attributed to higher species abundance in these areas. Because of the number of incidents in which the struck animal may not have been identified to species, the Navy cannot quantifiably predict that any proposed strike takes will be of a particular species, and therefore seeks take authorization for any combination of the following marine mammal stocks in the HSTT study area over the five year authorization.

Probability calculations used to justify the HSTT strike request values are contained in Section 6.6.2.

The Navy, therefore, is requesting three (3) ship strike takes to select large whale species and stocks over the five years of the authorization for the following stocks, with the caveat that no more than two (2) takes to any one species/stock would occur. Of these (3) strike requests, the Navy would request no more than (2) over the five years would be to:

- Gray whale (Eastern North Pacific)
- Fin whale (California, Oregon, Washington)
- Humpback whale (California, Oregon, California stock or Mexico DPS)
- Humpback whale (Central Pacific stock or Hawaii DPS)
- Sperm whale (Hawaiian Stock)

Of the (3) strike requests, the Navy would request no more than (1) over the five years would be to:

- Blue whale (Eastern North Pacific stock)
- Bryde's whale (Eastern Tropical Pacific stock)
- Bryde's whale (Hawaiian stock)
- Humpback whale (California, Oregon, California stock or Central America DPS)
- Minke whale (California, Oregon, Washington stock)
- Minke whale (Hawaiian Stock)
- Sperm whale (California, Oregon, Washington stock)
- Sei whale (Hawaiian stock)
- Sei whale (Eastern North Pacific stock)

The Navy would not request ship strike takes to the below stocks due to their relatively low occurrence in the Study Area in particular core HSTT training and testing subareas:

- Blue whale (Central North Pacific stock)
- Fin whale (Hawaiian stock)
- Gray whale (Western North Pacific stock)

Species Justification

The Navy refined its take request to those stocks most likely to be present based on documented abundance, and where overlap is between a species' common occurrence and core Navy training and testing areas within a given range complex.

A weight of evidence approach was used to qualitatively rank range complex specific species using historic and current stranding data from NMFS, relative abundance as derived by NMFS for the HSTT Phase II Biological Opinion, and the Navy funded monitoring within each range complex. Results of the weight of evidence approach are presented in the Table 5-4 for Hawaii and Southern California. The evaluation data and process for each element are subsequently explained after Table 5-4.

Table 5-4: Weight Of Evidence Approach For Determining HSTT Ship Strike Species

Species	Stock	Regional Ship Strike Stranding Data Eval. (yes=1; no =0)	NMFS Relative Abundance Data Eval. (yes=1; no =0)	Navy And Other Monitoring Data Eval. (yes=1; no =0)	Final Score	Justification *
HAWAII						
Blue whale	Central Pacific	no	no	no	0	Not include
Bryde's whale	Hawaiian	no	yes	yes	2	Include
Fin whale	Hawaiian	no	no	no	0	Not Include
Humpback whale	Central Pacific	yes	yes	yes	3	Include
Minke whale	Hawaiian	yes	no	yes	2	Include
Sei whale	Hawaiian	no	yes	yes	2	Include
Sperm whale	Hawaiian	yes	yes	yes	3	Include
SOUTHERN CALIFORNIA						
Blue whale	Eastern North Pacific	yes	yes	yes	3	Include
Bryde's whale	Eastern Tropical Pacific	no	no	yes	1	Include
Fin whale	California, Oregon, Washington	yes	yes	yes	3	Include
Gray whale	Eastern North Pacific	yes	yes	yes	3	Include
Gray whale	Western North Pacific	no	no	no	0	Not Include
Humpback whale	California, Oregon, Washington	yes	yes	yes	3	Include
Minke whale	California, Oregon, Washington	no	no	yes	1	Include
Sei whale	Eastern North Pacific	no	no	yes	1	Include
Sperm whale	California, Oregon, Washington	no	yes	yes	2	Include

Justification for inclusion in HSTT ship strike request based on any final score > zero (0)

Regional Ship Strike Stranding Date Evaluation- For the US West Coast, Rockwood et al. (2017) propose that the risk to blue whale, fin whales, and humpback whales along the US West Coast from commercial ships strike may be higher than reported in NMFS' stranding records. However, stranding records are the only source of definitive species identification and can help inform the decision on which species could be more at risk of a strike due to higher abundance and co-occurrence with the Proposed Activities.

For California, based on California stranding records provided by NMFS to the Navy in August 2011, for 1991 through 2009 more ships strikes (74%) occurred in parts of California north of and outside of the HSTT SOCAL area. During this period (1991-2009), the most commonly struck large whale were in order: gray whales (30), unknown whales (20), blue whales (14), fin whales (11), humpback whales (8), and sperm whale (1)(NMFS, unpublished data). For the California areas most associated with HSTT SOCAL (1991-2009), which in general is San Diego County, the most commonly struck large whales were: gray whales (9), unknown whales (5), fin whales (2), and blue whale (1). The Navy does not have more comprehensive large whale stranding data since 2009. However, Carretta et al. (2017a) does summarize marine mammal injury for the US West Coast from 2011-2015. By manually reviewing the authors species specific data table specifically for California ship strikes, the following ship strike were reported for the 2011-2015 period: blue whale (0), Bryde's whale (0), fin whale (7 in California outside SOCAL and 3 in SOCAL), gray whale (3 in California outside SOCAL and 1 in SOCAL), humpback whale (4 in California outside SOCAL and 2 in SOCAL), minke whale (0), sei whale (1 in California outside SOCAL and 0 in SOCAL), sperm whale (0). In correspondence with NMFS West Coast Region, they indicated that for the period from May 2015 through August 2017, there have only been two large whale ship strikes in San Diego County (1 gray whale, 1 humpback whale) both in 2016.

For Hawaii, Lammers et al (2013) reports the rate of collisions increased significantly over the final twelve breeding seasons in a study covering 1975-2011, and was greater than predicted by the estimated annual increase in the whale population. However, none of the collisions were immediately lethal. To the best of the Navy's knowledge, there has not been a blue whale (Central North Pacific stock), fin whale (Hawaiian stock), or sei whale (Hawaiian stock) ship strike in Hawaii. Regardless, there has never been a Navy ship strike to those species and stocks in Hawaii from over 20 years' worth of Navy records. In March 2012, NMFS provided the Navy with a list of large whale stranding records from 2003-2010 (NMFS, unpublished data). There were 53 total reported ship strikes with: humpback whale (50 or 94%), unknown whale (2), and sperm whale (1). The island specific breakdown was: Maui (55%), Hawaii (13%), Kauai (9%), Lanai (9%), Oahu (8%), and offshore (6%). Bradford and Lyman (2015) report on Hawaii cetacean injuries from human-related causes (2007-2012). In reviewing the author's data table for 2011-2012 events, there were eight (8) humpback whale strikes, and 1 strike to an unknown species.

In conclusion, the majority of NMFS ship strike stranding records for Southern California include blue whales, fin whales, gray whales, and humpback whales. The ship strike records for Hawaii include humpback whales, minke whales, and sperm whales.

NMFS Relative Abundance Evaluation- For NMFS' previous HSTT reinitiated Biological Opinion of 2 April 2015 , NMFS derived relative species-specific abundance values for large whales in HSTT. Table 5-5 shows those value ranked by area and from highest to lowest. A qualitative assessment to initially screen using a value of >0.039 was used which aligns for the most part with commonly detected species as discussed in the Navy And Other Monitoring Data Evaluation.

Navy And Other Monitoring Data Evaluation- There are several NMFS anecdotal and more recent publications including Navy passive acoustic monitoring reports that indicate fin whales or perhaps a sub-population of fin whales reside in SOCAL year-round (Scales et al. 2017, Širović et al. 2017). Blue whales, humpback whales, and sperm whales are more transitory and spend only portions of their lifecycle in SOCAL (Mate et al. 2016, 2017).

Gray whales are transitory only during two migration periods as they transit in two to three days through the Study Area (DeAngelis et al. 2015). Some small numbers of Western North Pacific gray whales have been documented traveling to Baja (Mate et al. 2015). However, more of this stock is suspected as overwintering in Asia and it is energetically costly to make a cross Pacific transit (Villegas-Amtmann et al. 2017). Therefore, the actual probability of Western North Pacific gray whales migrating through the Study Area is extremely low. Finally, the small population numbers and less likely use of Baja by Western Pacific gray whale combined with their rather rapid transit through the Study Area, means the probability of that stock being struck would be extremely low. Without genetics testing, it would likely never be known if any gray whale strike was to the more abundant Eastern Pacific stock, or Western Pacific stock. In terms of avoidance, McKenna et al. (2015) reported during nine observed encounters between blue whale and commercial ships in Southern California, the whales initiated a dive avoidance behavior in 55% of the observations, but no evidence for a lateral avoidance. Although all species of baleen found in Southern California except gray whales are also known to occur in the Hawaii, blue and fin whales are much less common than the other species. Bryde's whales are the only baleen whale expected to occur year round. Table 5-5 contains a brief assessment of species common occurrence in core Navy training and testing areas within HSTT. Information for the table is derived from the Navy's monitoring website for 2009-2016 reporting, and in academic papers arising out of Navy monitoring in HSTT (Kerosky et al. 2012, Heble et al 2016, Mate et al. 2016, 2017, Scales et al. 2017, Širović et al. 2017, Smultea et al. 2012).

Table 5-5. NMFS Relative Annual Abundance Of Large Whales In HSTT And Annotations From Navy Monitoring Data

Hawaii Species Stock	NMFS Relative Annual Abundance	Qualifying Information From Navy Monitoring Data On Detection In Core Navy Use Areas	Southern California Species Stock	NMFS Relative Annual Abundance	Qualifying Information From Navy Monitoring Data On Detection In Core Navy Use Areas
sperm whale Hawaiian	0.487223	Visually and passively acoustically commonly detected	**fin whale** California, Oregon, Washington	0.460267	Visually and passively acoustically commonly detected; satellite tracking tag data
humpback whale Central Pacific	0.245270	Visually and passively acoustically commonly detected	**gray whale** Eastern North Pacific	0.249293	Visually commonly detected seasonally
Bryde's whale Hawaiian	0.047732	Passively acoustically detected	**sperm whale** California, Oregon, Washington	0.106555	Visually and passively acoustically commonly detected
sei whale Hawaiian	0.040811	No detections	**blue whale** Eastern North Pacific	0.102608	Visually and passively acoustically commonly detected; satellite tracking tag data
minke whale Hawaiian	0.027122	Visually and passively acoustically commonly detected	**humpback whale** California, Oregon, Washington	0.040622	Visually and passively acoustically commonly detected
fin whale Hawaiian	0.027149	No detections	**Bryde's whale** Eastern Tropical Pacific	0.000264	Passively acoustically detected seasonally
blue whale Central Pacific	0.016206	No detections	**minke whale** California, Oregon, Washington	0.032494	Visually detected
			sei whale Eastern North Pacific	0.007280	Visually detected
			gray whale Western North Pacific	0.000299	No detections

Species listed above the large black line pass a NMFS Relative Abundance Evaluation criteria of >0.039. Species above the double line did not pass the abundance criteria, but additional documented information of their occurrence in HSTT used to qualitatively include these in the Navy's HSTT ship strike request.

6 Take Estimates for Marine Mammals

6.1 Estimated Take of Marine Mammals by Acoustic and Explosive Sources

Given the scope of the Navy activities at sea and the current state of the science regarding marine mammals, there is no known method to determine or predict the age, sex, or reproductive condition of the various species of marine mammals predicted to be taken as a result of the proposed Navy training and testing. There are 38 marine mammal species known to exist in the Study Area that are managed by NMFS (Table 3-1). The method for estimating the number and types of take is described in the sections below beginning with presentation of the criteria used for each type of take followed by the method for quantifying exposures of marine mammals to sources of energy exceeding those threshold values.

Long recognized by the scientific community (Payne & Webb, 1971), and summarized by the National Academies of Science, is the fact that human-generated sound could possibly harm marine mammals or significantly interfere with their normal activities (National Research Council, 2005). Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sound, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council, 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al., 2007b; Southall et al., 2007).

Furthermore, many other factors besides just the received level of sound may affect an animal's reaction such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound. Although it is clear that sound and encroachment can disturb marine mammals and alter their behaviors temporarily, there is currently an absence of observations or measurements that demonstrate that disturbance due to intermittent sound in the water will have long-term consequences for the animal or alter their behaviors to the point that they are abandoned or significantly altered over longer periods (i.e., greater than a few hours to a few days dependent upon the species and stressor).

6.2 Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities

A detailed discussion of the conceptual framework describing the potential effects from exposure to acoustic and explosive activities and the accompanying short-term costs to the animal (e.g., expended energy or missed feeding opportunity) can be found in Section 3.0.3.6.1 of the HSTT Draft EIS/OEIS. It then outlines the conditions that may lead to long-term consequences for the individual if the animal cannot fully recover from the short-term costs and how these in turn may affect the population. This section provides a generalized description of potential outcomes for any marine animal exposed to acoustic and explosive stressors. Sections 6.4.1 and 6.5.1 provide background data specific to marine mammals based on best available science and follow this conceptual framework for acoustic and explosive stressors, respectively.

An animal is considered "exposed" to a sound if the received sound level at the animal's location is above the background ambient noise level within a similar frequency band. A variety of effects may result from exposure to acoustic and explosive activities.

The categories of potential effects are:

- ***Injury*** *- Injury to organs or tissues of an animal.*
- ***Hearing loss*** *- A noise-induced decrease in hearing sensitivity which can be either temporary or permanent and may be limited to a narrow frequency range of hearing.*
- ***Masking*** *- When the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise).*
- ***Physiological stress*** *- An adaptive process that helps an animal cope with changing conditions; although, too much stress can result in physiological problems.*
- ***Behavioral response*** *- A reaction ranging from very minor and brief changes in attentional focus, changes in biologically important behaviors, and avoidance of a sound source or area, to aggression or prolonged flight.*

Figure 6-1 is a flowchart that diagrams the process used to evaluate the potential effects to marine animals exposed to sound-producing activities. The shape and color of each box on the flowchart represent either a decision point in the analysis (green diamonds); specific processes such as responses, costs, or recovery (blue rectangles); external factors to consider (purple parallelograms); and final outcomes for the individual or population (orange ovals and rectangles). Each box is labeled for reference throughout the following sections. For simplicity, sound is used here to include not only sound waves but also blast waves generated from explosive sources. Box A1, the Sound-Producing Activity, is the source of this stimuli and therefore the starting point in the analysis.

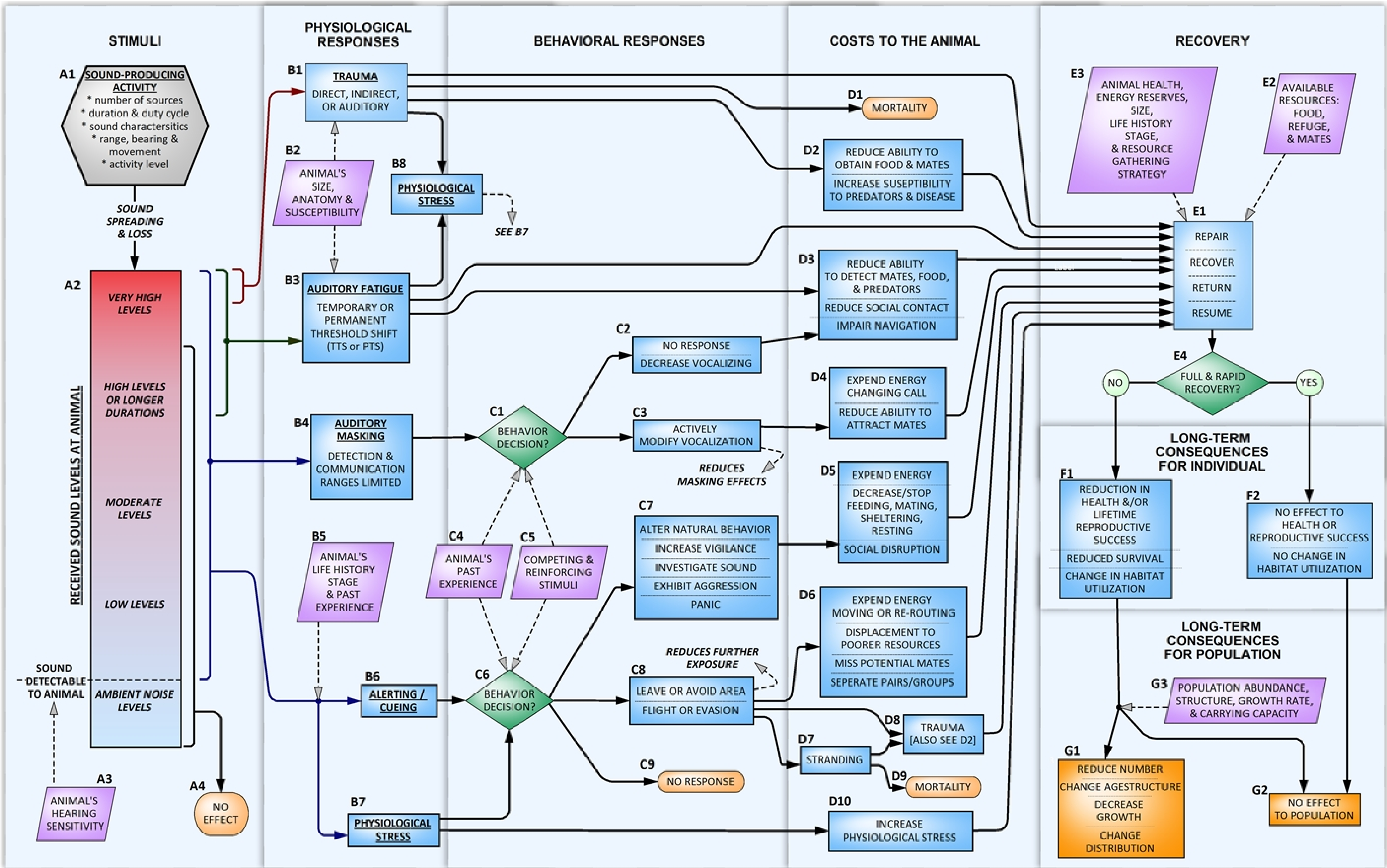

Figure 6-1. Flow Chart of the Evaluation Process of Sound-Producing Activities

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6.3 HEARING AND VOCALIZATION

The typical terrestrial mammalian ear (which is ancestral to that of marine mammals) consists of an outer ear that collects and transfers sound to the tympanic membrane and then to the middle ear (Fay & Popper, 1994; Rosowski, 1994). The middle ear contains ossicles that amplify and transfer acoustic energy to the sensory cells (called hair cells) in the cochlea, which transforms acoustic energy into electrical neural impulses that are transferred by the auditory nerve to high levels in the brain (Møller, 2013). All marine mammals display some degree of modification to the terrestrial ear; however, there are differences in the hearing mechanisms of marine mammals with an amphibious ear versus those with a fully aquatic ear (Wartzok & Ketten, 1999). Marine mammals with an amphibious ear include the marine carnivores: pinnipeds, sea otters, and polar bears (Ghoul & Reichmuth, 2014; Owen & Bowles, 2011; Reichmuth et al., 2013). Outer ear adaptations in this group include external pinnae (ears) that are reduced or absent, and in the pinnipeds, cavernous tissue, muscle, and cartilaginous valves seal off water from entering the auditory canal when submerged (Wartzok & Ketten, 1999). Marine mammals with the fully aquatic ear (cetaceans) use bone and fat channels in the head to conduct sound to the ear; while the auditory canal still exists in pinnipeds, it is narrow and sealed with wax and debris, and external pinnae are absent (Houser & Mulsow, 2016; Ketten, 1998).

The most accurate means of determining the hearing capabilities of marine mammal species are direct measures that assess the sensitivity of the auditory system (Nachtigall et al., 2000; Supin et al., 2001). Studies using these methods produce audiograms — plots describing hearing threshold (the quietest sound a listener can hear) as a function of frequency. Marine mammal audiograms, like those of terrestrial mammals, typically have a “U-shape,” with a frequency region of best hearing sensitivity and a progressive decrease in sensitivity outside of the range of best hearing (Fay, 1988; Mooney et al., 2012; Nedwell et al., 2004; Reichmuth et al., 2013). The “gold standard” for producing audiograms is the use of behavioral (psychophysical) methods, where marine mammals are trained to respond to acoustic stimuli (Nachtigall et al., 2000). For species that are untrained for behavioral psychophysical procedures, those that are difficult to house under human care, or in stranding rehabilitation and temporary capture contexts, auditory evoked potential methods are increasingly used to measure hearing sensitivity (e.g., Castellote et al., 2014; Finneran et al., 2009; Montie et al., 2011; Mulsow et al., 2011; Nachtigall et al., 2007; Nachtigall et al., 2008; Supin et al., 2001).

These auditory evoked potential methods, which measure electrical potentials generated by the auditory system in response to sound and do not require the extensive training of psychophysical methods, can provide an efficient estimate of behaviorally measured sensitivity (Finneran & Houser, 2006; Schlundt et al., 2007; Yuen et al., 2005). The thresholds provided by auditory evoked potential methods are, however, typically elevated above behaviorally measured thresholds, and auditory evoked potential methods are not appropriate for estimating hearing sensitivity at frequencies much lower than the region of best hearing sensitivity (Finneran et al., 2016). For marine mammal species for which access is limited and therefore psychophysical or AEP testing is impractical (e.g., mysticete whales and rare species), some aspects of hearing can be estimated from anatomical structures, frequency content of vocalizations, and extrapolations from related species. Direct measurements of hearing sensitivity exist for approximately 25 of the nearly 130 species of marine mammals. Table 6-1 summarizes hearing capabilities for marine mammal species in the study area.

Table 6-1: Species Within Marine Mammal Hearing Groups Likely Found in the Study Area

Hearing Group	***Species within the Study Area***
High-frequency cetaceans	Dall’s porpoise
	Dwarf sperm whale
	Pygmy sperm whale
Mid-frequency cetaceans	Baird’s beaked whale
	Blainville’s beaked whale
	Common bottlenose dolphin
	Cuvier’s beaked whale
	False killer whale
	Fraser’s dolphin
	Ginkgo-toothed beaked whale
	Hubbs’ beaked whale
	Killer whale
	Long-beaked common dolphin
	Longman’s beaked whale
	Melon-headed whale
	Northern right whale dolphin
	Pacific white-sided dolphin
	Pantropical spotted dolphin
	Perrin’s beaked whale
	Pygmy beaked whale
	Pygmy killer whale
	Risso’s dolphin
	Rough-toothed dolphin
	Short-beaked common dolphin
	Short-finned pilot whale
	Sperm whale
	Spinner dolphin
	Striped dolphin
	Stejneger’s beaked whale
Low-frequency cetaceans	Blue whale
	Bryde’s whale
	Fin whale
	Gray whale
	Humpback whale
	Minke whale
	Sei whale
Otariids and other non-phocid marine carnivores	California sea lion
	Guadalupe fur seal
	Northern fur seal
Phocids	Harbor seal
	Hawaiian monk seal
	Northern elephant seal

For this analysis, marine mammals are arranged into the following functional hearing groups based on their generalized hearing sensitivities: high-frequency cetaceans (group HF: porpoises, Kogia spp.), mid-frequency cetaceans (group MF: delphinids, beaked whales, sperm whales), low-frequency cetaceans (group LF: mysticetes), otariids and other non-phocid marine carnivores in water and air (groups OW and OA: sea lions, walruses, otters, polar bears), and phocids in water and air (group PW and PA: true seals). Note that the designations of high-, mid-, and low-frequency cetaceans are based on relative differences of sensitivity between groups, as opposed to conventions used to describe active sonar systems.

For Phase III analyses a single representative composite audiogram (Figure 6-2) was created for each functional hearing group using audiograms from published literature. For discussion of all marine mammal functional hearing groups and their derivation see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017c).

The mid-frequency cetacean composite audiogram is consistent with recently published behavioral audiograms of killer whales (Branstetter et al., 2017). The mid-frequency cetacean composite audiogram is consistent with recently published behavioral audiograms of killer whales (Branstetter et al., 2017). The otariid and phocid composite audiograms are consistent with recently published behavioral audiograms of pinnipeds; these behavioral audiograms also show that pinniped hearing sensitivity at frequencies and thresholds far above the range of best hearing may drop off at a slower rate than previously predicted (Cunningham & Reichmuth, 2015).

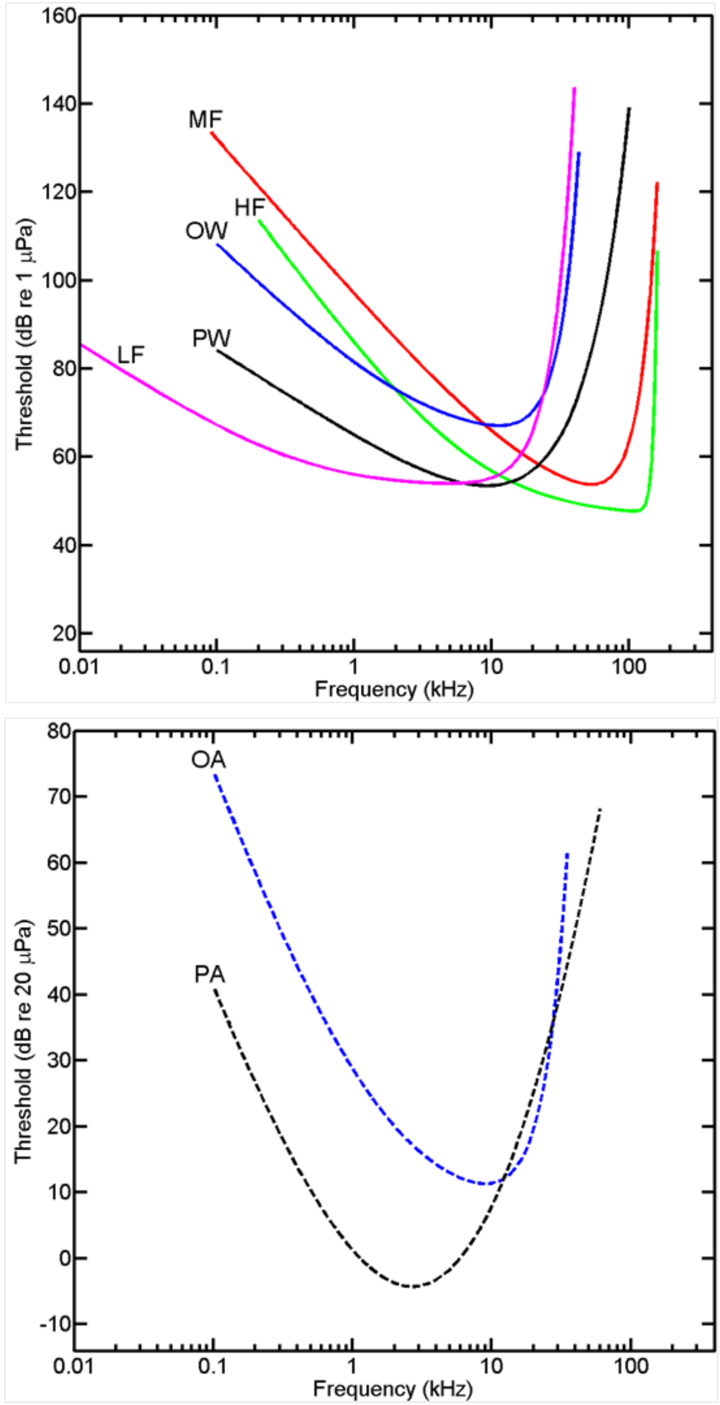
Similar to the diversity of hearing capabilities among species, the wide variety of acoustic signals used in marine mammal communication (including biosonar or echolocation) is reflective of the diverse ecological characteristics of cetacean and carnivore species (see Avens & Lohmann, 2003; Richardson et al., 1995). This makes a succinct summary difficult (see Richardson et al., 1995; Wartzok & Ketten, 1999 for thorough reviews); however, a division can be drawn between lower-frequency communication signals that are used by marine mammals in general, and the specific, high-frequency biosonar signals that are used by odontocetes to sense their environment.

Non-biosonar communication signals span a wide frequency range, primarily having energy up into the tens of kilohertz range. Of particular note are the very low-frequency calls of mysticete whales that range from tens of hertz to several kilohertz, and have source levels of 150 to 200 dB re 1 µPa (Cummings & Thompson, 1971; Edds-Walton, 1997; Širović et al., 2007; Stimpert et al., 2007; Wartzok & Ketten, 1999). These calls most likely serve social functions such as mate attraction, but may serve an orientation function as well (Green, 1994; Green et al., 1994; Richardson et al., 1995). Humpback whales are a notable exception within the mysticetes, with some calls exceeding 10 kHz (Zoidis et al., 2008).

Odontocete cetaceans and marine carnivores use underwater communicative signals that, while not as low in frequency as those of many mysticetes, likely serve similar functions. These include tonal whistles in some odontocetes, the calls of manatees and dugongs, and the wide variety of barks, grunts, clicks, sweeps, and pulses of pinnipeds. Of additional note are the aerial vocalizations that are produced by pinnipeds, otters, and polar bears. Again, the acoustic characteristics of these signals are quite diverse among species, but can be generally classified as having dominant energy at frequencies below 20 kHz (Richardson et al., 1995; Wartzok & Ketten, 1999).

Odontocete cetaceans generate short-duration (500–200 µs), specialized clicks used in biosonar with peak frequencies between 10 and 200 kHz to detect, localize, and characterize underwater objects such as prey (Au, 1993; Wartzok & Ketten, 1999). These clicks are often more intense than other communicative signals, with reported source levels as high as 229 dB re 1 µPa peak-to-peak (Au et al., 1974). The echolocation clicks of high-frequency cetaceans (e.g., porpoises) are narrower in bandwidth (i.e., the difference between the upper and lower frequencies in a sound) and higher in frequency than those of mid-frequency cetaceans (Madsen et al., 2005; Villadsgaard et al., 2007).

In general, frequency ranges of vocalization lie within the audible frequency range for an animal (i.e., animals vocalize within their audible frequency range); however, auditory frequency range and vocalization frequencies do not perfectly align. The frequency range of vocalization in a species can therefore be used to infer some characteristics of their auditory system; however, caution must be taken when considering vocalization frequencies alone in predicting the hearing capabilities of species for which no data exist (i.e., mysticetes). It is important to note that aspects of vocalization and hearing sensitivity are subject to evolutionary pressures that are not solely related to detecting communication signals. For example, hearing plays an important role in detecting threats (e.g., Deecke et al., 2002), and high-frequency hearing is advantageous to animals with small heads in that it facilitates sound localization based on differences in sound levels at each ear (Heffner and Heffner 1992). This may be partially responsible for the difference in best hearing thresholds and dominant vocalization frequencies in some species of marine mammals (e.g., Steller sea lions, Mulsow & Reichmuth, 2010).



For hearing in water (top) and in air (bottom, phocids and otariids only). LF = low frequency, MF = mid-frequency, HF = high frequency, OW = otariids and other non-phocid marine carnivores in water, PW = phocids in water, OA = otariids and other non-phocid marine carnivores in air, PA = phocids in air. Source: Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III) (U.S. Department of the Navy, 2017)

Figure 6-2: Composite Audiograms for Hearing Groups Likely Found in the Study Area

6.4 ACOUSTIC STRESSORS

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic sources, the marine mammals that may be present in the vicinity of the sources, and the effects that sound may have on the physiology and behavior of those marine mammals. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council, 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the significance of responses by marine mammals to sound exposures (Nowacek et al., 2007b; Southall et al., 2007). Furthermore, many other factors besides just the received level of sound may affect an animal's reaction such as the duration of the sound producing activity, the animal's physical condition, prior experience with the sound, activity at the time of exposure (e.g., feeding, traveling, resting), the context of the exposure (e.g., in a semi-enclosed bay vs open ocean), and proximity to the source of the sound.

The ways in which an acoustic exposure could result in immediate effects or long-term consequences for an animal are explained in the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 6.2). The following Background section discusses what is currently known about acoustic effects to marine mammals. These effects could hypothetically extend from physical injury or trauma to a behavioral or stress response that may or may not be detectable. Injury (physical trauma) can occur to organs or tissues of an animal (Section 6.4.1.1, Injury). Hearing loss (Section 6.4.1.2, Hearing Loss and Auditory Injury) is a noise-induced decrease in hearing sensitivity, which can be either temporary or permanent. Masking (Section 6.4.1.4, Masking) can occur when the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise). Physiological stress (Section 6.4.1.3, Physiological Stress) is an adaptive process that helps an animal cope with changing conditions, however too much stress can result in physiological effects. Behavioral response (Section 6.4.1.5, Behavioral Reactions) ranges from brief distractions to avoidance of a sound source to prolonged flight. Extreme behavioral or physiological responses can lead to stranding (Section 6.4.1.5, Behavioral Reactions). Long-term consequences (Section 6.4.1.7, Long-Term Consequences) are those impacts, or accumulation of impacts, that can result in decreases in individual fitness or population changes. In order to reduce or avoid as many of these impacts as possible, the Navy implements marine mammal mitigation measures during most Navy training and testing activities (see Chapter 11, Mitigation Measures).

6.4.1 BACKGROUND

6.4.1.1 Injury

Injury (i.e., physical trauma) refers to the effects on the tissues or organs of an animal due to exposure to pressure waves. Injury due to exposure to non-explosive acoustic stressors such as sonar is discussed below. Moderate- to low-level sound sources including vessel and aircraft noise would not cause any injury. The Conceptual Framework for Assessing Effects from Sound-Producing Activities (see Section 6.2) provides additional information on injury (i.e., physical trauma) and the framework used to analyze this potential impact.

Several mechanisms of acoustically-induced tissue damage (non-auditory) have been proposed and are discussed below.

6.4.1.1.1 Injury due to Sonar-Induced Acoustic Resonance

An object exposed to its resonant frequency will tend to amplify its vibration at that frequency, a phenomenon called acoustic resonance. Acoustic resonance has been proposed as a mechanism by which a sonar or sources with similar operating characteristics could damage tissues of marine mammals. In 2002, NMFS convened a panel of government and private scientists to investigate the potential for acoustic resonance to occur in marine mammals (National Oceanic and Atmospheric Administration, 2002). They modeled and evaluated the likelihood that Navy mid-frequency sonar caused resonance effects in beaked whales that eventually led to their stranding. The conclusions of the group were that resonance in air-filled structures was not likely to have caused the Bahamas stranding in 2000. The frequency at which resonance was predicted to occur in the animals' lungs was 50 Hz, well below the frequencies used by the mid-frequency sonar systems associated with the Bahamas event. Furthermore, air cavity vibrations, even at resonant frequencies, were not considered to be of sufficient amplitude to cause tissue damage, even under the unrealistic scenario in which air volumes would be undamped (unrestrained) by surrounding tissues and the amplitude of the resonant response would be greatest. These same conclusions would apply to other training and testing activities involving acoustic sources. Therefore, the Navy concludes that acoustic resonance would not occur under realistic conditions during training and testing activities, and this type of impact is not considered further in this analysis.

6.4.1.1.2 Nitrogen Decompression

Marine mammals are thought to deal with nitrogen loads in their blood and other tissues, caused by gas exchange from the lungs under conditions of high ambient pressure during diving, through anatomical, behavioral, and physiological adaptations (Hooker et al., 2012).

Although not a direct injury, variations in marine mammal diving behavior or avoidance responses could result in nitrogen off-gassing in super-saturated tissues, possibly to the point of deleterious vascular and tissue bubble formation (Hooker et al., 2012; Jepson et al., 2003; Saunders et al., 2008) with resulting symptoms similar to decompression sickness (also known as "the bends"). The process has been under debate in the scientific community (Hooker et al., 2012; Saunders et al., 2008), although analyses of by-caught and drowned animals has demonstrated that nitrogen bubble formation can occur once animals are brought to the surface and tissues are supersaturated with nitrogen (Bernaldo de Quiros et al., 2013b; Moore et al., 2009). Deep diving whales, such as beaked whales, normally have higher nitrogen loads in body tissues, which may make them more susceptible to decompression for certain modeled changes in dive behavior (Fahlman et al., 2014b; Fernández et al., 2005; Hooker et al., 2012; Jepson et al., 2003).

Researchers have examined how dive behavior affects tissue supersaturation conditions that could put an animal at risk of gas bubble embolism. An early hypothesis was that if exposure to a startling sound elicits a rapid ascent to the surface, tissue gas saturation sufficient for the evolution of nitrogen bubbles might result (Fernández et al., 2005; Jepson et al., 2003). However, modeling suggested that even unrealistically rapid rates of ascent from normal dive behaviors are unlikely to result in supersaturation to the extent that bubble formation would be expected in beaked whales (Zimmer & Tyack, 2007). Instead, emboli observed in animals exposed to mid-frequency active sonar (Fernández et al., 2005; Jepson et al., 2003) could stem from a behavioral response that involves repeated dives, shallower than the depth of lung collapse (Hooker et al., 2012; Tyack et al., 2006; Zimmer & Tyack, 2007). Longer times spent diving at mid-depths above lung collapse would allow gas exchange from the lungs to continue under high hydrostatic pressure conditions, increasing potential for supersaturation; below the depth of

lung collapse, gas exchange from the lungs to the blood would likely not occur (Fahlman et al., 2014b). However, Costidis and Rommel (Costidis & Rommel, 2016) suggest that gas exchange may continue to occur across the tissues of air-filled sinuses in deep-diving odontocetes below the depth of lung collapse, if hydrostatic pressures are high enough to drive gas exchange across into non-capillary veins, contributing to tissue gas loads. To examine the potential for gas bubble formation, a bottlenose dolphin was trained to dive repetitively to depths shallower than lung collapse to elevate nitrogen saturation to the point that asymptomatic nitrogen bubble formation was predicted to occur. However, inspection of the vascular system of the dolphin via ultrasound did not demonstrate the formation of any nitrogen gas bubbles (Houser et al., 2009). To estimate risk of decompression sickness, Kvadsheim et al. (2012) modeled gas exchange in the tissues of sperm, pilot, killer, and beaked whales based on actual dive behavior during exposure to sonar in the wild. Results indicated that venous supersaturation was within the normal range for these species, which have naturally high levels of nitrogen loading. Researchers have also considered the role of accumulation of carbon dioxide produced during periods of high activity by an animal, theorizing that accumulating carbon dioxide, which cannot be removed by gas exchange below the depth of lung collapse, may facilitate the formation of bubbles in nitrogen saturated tissues (Bernaldo de Quiros et al., 2012; Fahlman et al., 2014b).

Modeling has suggested that the long, deep dives performed regularly by beaked whales over a lifetime could result in the saturation of long-halftime tissues (i.e., tissues that take longer to give off nitrogen, e.g., fat and bone lipid) to the point that they are supersaturated when the animals are at the surface (Fahlman et al., 2014b; Hooker et al., 2009; Saunders et al., 2008). The presence of osteonecrosis (bone death due to reduced blood flow) in deep diving sperm whales has been offered as evidence of chronic supersaturation (Moore & Early, 2004). Proposed adaptations for prevention of bubble formation under conditions of persistent tissue saturation have been suggested (Fahlman et al., 2006; Hooker et al., 2009), while the condition of supersaturation required for bubble formation in these tissues has been demonstrated in marine mammals drowned at depth as fisheries bycatch and brought to the surface (Moore et al., 2009). For beaked whale strandings associated with sonar use, one theory is that observed bubble formation may be caused by long periods of compromised blood flow caused by the stranding itself (which reduces ability to remove nitrogen from tissues) following rapid ascent dive behavior that does not allow for typical management of nitrogen in supersaturated, long-halftime tissues (Houser et al., 2009).

A fat embolic syndrome (out of place fat particles, typically in the bloodstream) was identified by Fernández et al. (2005) coincident with the identification of bubble emboli in stranded beaked whales. The fat embolic syndrome was the first pathology of this type identified in marine mammals and was thought to possibly arise from the formation of bubbles in fat bodies, which subsequently resulted in the release of fat emboli into the blood stream.

Dennison et al. (2011) reported on investigations of dolphins stranded in 2009–2010 and, using ultrasound, identified gas bubbles in kidneys of 21 of the 22 live-stranded dolphins and in the liver of two of the 22. The authors postulated that stranded animals are unable to recompress by diving, and thus may retain bubbles that are otherwise re-absorbed in animals that can continue to dive. The researchers concluded that the minor bubble formation observed could be tolerated since the majority of stranded dolphins released did not re-strand.

The appearance of extensive bubble and fat emboli in beaked whales is unique to strandings associated with certain high intensity sonar events; the phenomenon has not been observed in other stranded

marine mammals, including other beaked whale strandings not associated with sonar use. Thus, it is uncertain as to whether there is some mechanism for this phenomenon specific to beaked whales or whether the phenomenon occurs only following rapidly occurring stranding events (i.e., when whales are not capable of sufficiently decompressing). Because of the lack of evidence for extensive nitrogen bubble formation while diving, the Navy believes that the potential for marine mammals to get "the bends" following acoustic exposure to be unlikely and does not consider it in its effect analysis.

6.4.1.1.3 Acoustically-Induced Bubble Formation due to Sonars

A suggested cause of injury to marine mammals is rectified diffusion (Crum & Mao, 1996), the process of increasing the size of a microscopic gas bubble by exposing it to a sound field. The process is dependent upon a number of factors including the sound pressure level (SPL) and duration. Under this hypothesis, microscopic bubbles assumed to exist in the tissues of marine mammals may experience one of three things: (1) bubbles grow to the extent that tissue hemorrhage (injury) occurs, (2) bubbles develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs (a stress response without injury), or (3) the bubbles are cleared by the lung without negative consequence to the animal.

Rectified diffusion is facilitated if the environment in which the ensonified bubbles exist is supersaturated with gas. As discussed above, repetitive diving by marine mammals can cause the blood and some tissues to become supersaturated (Ridgway & Howard, 1979). The dive patterns of some marine mammals (e.g., beaked whales) are predicted to induce greater supersaturation (Houser et al., 2001). If rectified diffusion were possible in marine mammals exposed to high-level sound, conditions of tissue supersaturation could theoretically speed the rate and increase the size of bubble growth. Subsequent effects due to tissue trauma and emboli would presumably mirror those observed in humans suffering from decompression sickness.

It is unlikely that the short duration of sonar pulses would be long enough to drive bubble growth to any substantial size, if such a phenomenon occurs. However, an alternative but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of supersaturated tissues. In such a scenario, the marine mammal would need to be in a gas-supersaturated state for a long enough time for bubbles to become a problematic size. The phenomena of bubble growth due to a destabilizing exposure was shown by Crum et al. (2005) by exposing highly supersaturated ex vivo bovine tissues to a 37 kHz source at 214 dB re 1 µPa. Although bubble growth occurred under the extreme conditions created for the study, these conditions would not exist in the wild because the levels of tissue supersaturation in the study (as high as 400–700 percent) are substantially higher than model predictions for marine mammals (Fahlman et al., 2009; Fahlman et al., 2014b; Houser et al., 2001; Saunders et al., 2008), and such high exposure level would only occur in very close proximity to the most powerful sonars. It is improbable that this mechanism is responsible for stranding events or traumas associated with beaked whale strandings.

There has been considerable disagreement among scientists as to the likelihood of this phenomenon (Evans & Miller, 2003; Piantadosi & Thalmann, 2004). Although it has been argued that traumas from beaked whale strandings are consistent with gas emboli and bubble-induced tissue separations (Fernández et al., 2005; Jepson et al., 2003), nitrogen bubble formation as the cause of the traumas has not been verified. The presence of bubbles postmortem, particularly after decompression, is not

necessarily indicative of bubble pathology (Bernaldo de Quiros et al., 2012; Bernaldo de Quiros et al., 2013a; Bernaldo de Quiros et al., 2013b; Dennison et al., 2011; Moore et al., 2009).

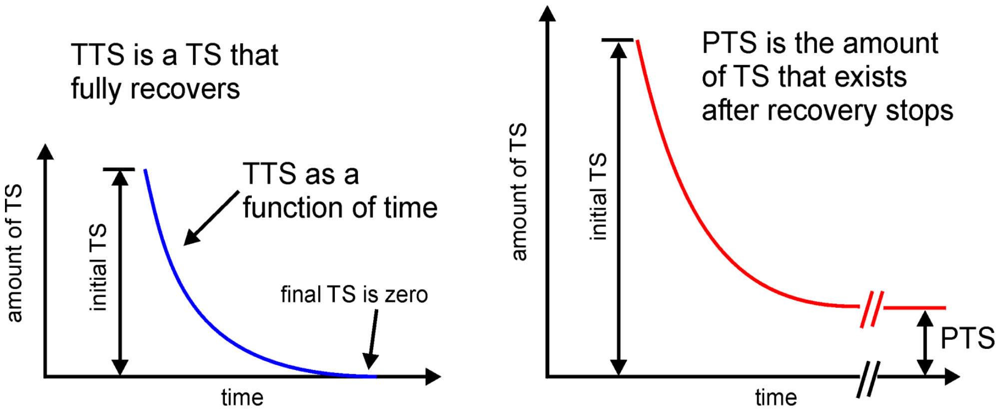
6.4.1.2 Hearing Loss and Auditory Injury

Exposure to intense sound may result in noise-induced hearing loss that persists after cessation of the noise exposure. Hearing loss may be temporary or permanent, depending on factors such as the exposure frequency, received sound pressure level, temporal pattern, and duration. The frequencies affected by hearing loss will vary depending on the frequency of the fatiguing noise, with frequencies at and above the noise frequency most strongly affected. The amount of hearing loss may range from slight to profound, depending on the ability of the individual to hear at the affected frequencies. Hearing loss has only been studied in a few species of marine mammals, although hearing studies with terrestrial mammals are also informative.

Hearing loss is typically quantified in terms of threshold shift (TS) — the amount (in dB) that hearing thresholds at one or more specified frequencies are elevated, compared to their pre-exposure values, at some specific time after the noise exposure. The amount of TS measured usually decreases with increasing recovery time — the amount of time that has elapsed since a noise exposure. If the TS eventually returns to zero (i.e., the hearing threshold returns to the pre-exposure value), the threshold shift is called a temporary threshold shift (TTS). If the TS does not completely recover (the threshold remains elevated compared to the pre-exposure value), the remaining TS is called a permanent threshold shift (PTS). TTS: **temporary threshold shift; TS: threshold shift; PTS: permanent threshold shift**

Figure 6-3 shows two hypothetical TSs: one that completely recovers, a TTS, and one that does not completely recover, leaving some PTS. By definition, TTS is a function of the recovery time, therefore comparing the severity of noise exposures based on the amount of induced TTS can only be done if the recovery times are also taken into account. For example, a 20-dB TTS measured 24 hr post-exposure indicates a more hazardous exposure than one producing 20 dB of TTS measured only 2 min after exposure; if the TTS is 20 dB after 24 h, the TTS measured after 2 min would likely be much higher. Conversely, if 20 dB of TTS was measured after 2 min, the TTS measured after 24 hr would likely be much smaller.

Studies have revealed that intense noise exposures may also cause auditory system injury that does not result in PTS; i.e., hearing thresholds return to normal after the exposure, but there is injury nonetheless. Kujawa and Liberman (2009) found that noise exposures sufficient to produce a TTS in neural thresholds of 40 dB, measured 24 hr post-exposure, resulted in acute loss of nerve terminals and delayed degeneration of the cochlear nerve in mice. Lin et al. (2011) found a similar result in guinea pigs, that a TTS in auditory evoked potential of up to approximately 50 dB, measured 24 hr post-exposure, resulted in neural degeneration. These studies demonstrate that PTS should not be used as the sole indicator of auditory injury, since exposures producing high levels of TTS (40 to 50 dB measured 24 hr after exposure) — but no PTS — may result in auditory injury.



TTS: temporary threshold shift; TS: threshold shift; PTS: permanent threshold shift

Figure 6-3: Two Hypothetical Threshold Shifts

There are no simple functional relationships between TTS and the occurrence of PTS or other auditory injury (e.g., neural degeneration). However, TTS and PTS are, by definition, mutually exclusive: An exposure that produces TTS cannot also produce PTS in the same individual; conversely, if an initial threshold shift only partially recovers, resulting in some amount PTS, the difference between the initial TS and the PTS is not called TTS. As TTS increases, the likelihood that additional exposure SPL or duration will result in PTS and/or other injury also increases. Exposure thresholds for the occurrence of PTS or other auditory injury can therefore be defined based on a specific amount of TTS; i.e., although an exposure has been shown to produce only TTS, we assume that any additional exposure may result in some PTS or other injury. The specific upper limit of TTS is based on experimental data showing amounts of TTS that have not resulted in PTS or injury. In other words, we do not need to know the exact functional relationship between TTS and PTS or other injury, we only need to know the upper limit for TTS before some PTS or injury is possible.

A variety of human and terrestrial mammal data indicate that threshold shifts up to 40 to 50 dB may be induced without PTS, and that 40 dB is a precautionary upper limit for allowable threshold shift to prevent PTS (e.g., Kryter et al., 1965; Miller et al., 1963; Ward, 1960; Ward et al., 1958; Ward et al., 1959). It is reasonable to assume the same relationship would hold for marine mammals, since there are many similarities between the inner ears of marine and terrestrial mammals and experiments with marine mammals have revealed similarities to terrestrial mammals for features such as TTS, age-related hearing loss, drug-induced hearing loss, masking, and frequency selectivity (Finneran et al., 2005a; Finneran, 2015; Ketten, 2000). Therefore, we assume that sound exposures sufficient to produce 40 dB of TTS measured ~4 min after exposure represent the limit of a non-injurious exposure; i.e., higher level exposures have the potential to cause auditory injury. Exposures sufficient to produce a TTS of 40 dB, measured ~4 min after exposure, therefore represent the threshold for auditory injury. The predicted injury could consist of either hair cell damage/loss resulting in PTS or other auditory injury, such as the delayed neural degeneration identified by Kujawa and Liberman (2009) and Lin et al. (2011) that may not result in PTS.

Numerous studies have directly examined noise-induced hearing loss in marine mammals (see Finneran, 2015). In these studies, hearing thresholds were measured in marine mammals before and after exposure to intense sounds. The difference between the pre-exposure and post-exposure thresholds

was then used to determine the amount of TTS at various post-exposure times. The major findings from these studies include the following:

- The method used to test hearing may affect the resulting amount of measured TTS, with neurophysiological measures producing larger amounts of TTS compared to psychophysical measures (Finneran et al., 2007; Finneran, 2015).
- The amount of TTS varies with the hearing test frequency. As the exposure SPL increases, the frequency at which the maximum TTS occurs also increases (Kastelein et al., 2014b). For high level exposures, the maximum TTS typically occurs one-half to one octave above the exposure frequency (Finneran et al., 2007; Mooney et al., 2009a; Nachtigall et al., 2004; Popov et al., 2011; Popov et al., 2013; Schlundt et al., 2000). The overall spread of TTS from tonal exposures can therefore extend over a large frequency range; i.e., narrowband exposures can produce broadband (greater than one octave) TTS.
- The amount of TTS increases with exposure SPL and duration, and is correlated with sound exposure level (SEL), especially if the range of exposure durations is relatively small (Kastak et al., 2007; Kastelein et al., 2014b; Popov et al., 2014). As the exposure duration increases, however, the relationship between TTS and SEL begins to break down. Specifically, duration has a more significant effect on TTS than would be predicted on the basis of SEL alone (Finneran et al., 2010a, 2010b; Kastak et al., 2005; Mooney et al., 2009a). This means if two exposures have the same SEL but different durations, the exposure with the longer duration (thus lower SPL) will tend to produce more TTS than the exposure with the higher SPL and shorter duration. In most acoustic impact assessments, the scenarios of interest involve shorter duration exposures than the marine mammal experimental data from which impact thresholds are derived; therefore, use of SEL tends to over-estimate the amount of TTS. Despite this, SEL continues to be used in many situations because it is relatively simple, more accurate than SPL alone, and lends itself easily to scenarios involving multiple exposures with different SPL.
- The amount of TTS depends on the exposure frequency. Sounds at low frequencies, well below the region of best sensitivity, are less hazardous than those at higher frequencies, near the region of best sensitivity (Finneran & Schlundt, 2013). The onset of TTS — defined as the exposure level necessary to produce 6 dB of TTS (i.e., clearly above the typical variation in threshold measurements) — also varies with exposure frequency. At low frequencies onset-TTS exposure levels are higher compared to those in the region of best sensitivity.
- TTS can accumulate across multiple exposures, but the resulting TTS will be less than the TTS from a single, continuous exposure with the same SEL (Finneran et al., 2010b; Kastelein et al., 2014c; Kastelein et al., 2015b; Mooney et al., 2009b). This means that TTS predictions based on the total, cumulative SEL will overestimate the amount of TTS from intermittent exposures such as sonars and impulsive sources.
- The amount of observed TTS tends to decrease with increasing time following the exposure; however, the relationship is not monotonic (i.e., increasing exposure does not always increase TTS). The time required for complete recovery of hearing depends on the magnitude of the initial shift; for relatively small shifts recovery may be complete in a few minutes, while large shifts (e.g., ~40 dB) may require several days for recovery. Under many circumstances TTS recovers linearly with the logarithm of time (Finneran et al., 2010a, 2010b; Finneran & Schlundt,

2013; Kastelein et al., 2012a; Kastelein et al., 2012b; Kastelein et al., 2013a; Kastelein et al., 2014b, 2014c; Kastelein et al., 2014d; Popov et al., 2011; Popov et al., 2013; Popov et al., 2014). This means that for each doubling of recovery time, the amount of TTS will decrease by the same amount (e.g., 6 dB recovery per doubling of time).

Due to the higher exposure levels or longer exposure durations required to induce hearing loss, only a few types of man-made sound sources have the potential to cause a threshold shift to a marine mammal in the wild. These include some sonars and other transducers and impulsive sound sources such as air guns and impact pile driving.

6.4.1.2.1 Threshold Shift due to Sonars and Other Transducers

TTS in mid-frequency cetaceans exposed to non-impulsive sound has been investigated in multiple studies (Finneran et al., 2005b; Finneran et al., 2010a; Finneran & Schlundt, 2013; Mooney et al., 2009a; Mooney et al., 2009b; Nachtigall et al., 2003; Nachtigall et al., 2004; Popov et al., 2013; Popov et al., 2014; Schlundt et al., 2000) from two species, bottlenose dolphins and beluga whales. Two high-frequency cetacean species have been studied for TTS due to non-impulsive sources: the harbor porpoise (Kastelein et al., 2012b) and the finless porpoise (*Neophocaena phocaenoides*) (Popov et al., 2011). TTS from non-impulsive sounds has also been investigated in three pinniped species: harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), and Northern elephant seal (*Mirounga angustirostris*) (e.g., Kastak et al., 2005; Kastelein et al., 2012a). These data are reviewed in detail in Finneran (2015), as well as the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017c) and the major findings are summarized above.

6.4.1.2.2 Threshold Shift due to Impulsive Sound Sources

Marine mammal TTS data from impulsive sources are limited to two studies with measured TTS of 6 dB or more: Finneran et al. (2002) reported behaviorally-measured TTSs of 6 and 7 dB in a beluga exposed to single impulses from a seismic water gun and Lucke et al. (2009) reported AEP-measured TTS of 7 to 20 dB in a harbor porpoise exposed to single impulses from a seismic air gun.

In addition to these data, Kastelein et al. (2015a) reported behaviorally-measured mean TTS of 4 dB at 8 kHz and 2 dB at 4 kHz after a harbor porpoise was exposed to a series of impulsive sounds produced by broadcasting underwater recordings of impact pile driving strikes through underwater sound projectors. The cumulative SEL was approximately 180 dB re 1 $\mu Pa^2 s$. The pressure waveforms for the simulated pile strikes exhibited significant “ringing” not present in the original recordings and most of the energy in the broadcasts was between 500 and 800 Hz. As a result, some questions exist regarding whether the fatiguing signals were representative of underwater pressure signatures from impact pile driving.

Several impulsive noise exposure studies have also been conducted without behaviorally measurable TTS. Finneran et al. (2000) exposed dolphins and belugas to single impulses from an “explosion simulator” and Finneran et al. (2015) exposed three dolphins to sequences of 10 impulses from a seismic air gun (maximum cumulative SEL = 193 to 195 dB re 1 $\mu Pa^2 s$, peak SPL =196 to 210 dB re 1 μPa) without measurable TTS. Finneran et al. (2003b) exposed two sea lions to single impulses from an arc-gap transducer with no measurable TTS (maximum unweighted SEL = 163 dB re 1 $\mu Pa^2 s$, peak SPL = 183 dB re 1 μPa).

6.4.1.3 Physiological Stress

The growing field of conservation physiology relies in part on the ability to monitor stress hormones in populations of animals, particularly those that are threatened or endangered. The ability to make predictions from stress hormones about impacts to individuals and populations exposed to various forms of stressors, natural and human-caused, relies on understanding the linkages between changes in stress hormones and resulting physiological impacts. At this time, the sound characteristics that correlate with specific stress responses in marine mammals are poorly understood, as are the ultimate consequences due to these changes. Navy-funded efforts are underway to try to improve our understanding and ability to predict how stressors ultimately affect marine mammal populations (e.g., King et al., 2015; New et al., 2013a; New et al., 2013b; Pirotta et al., 2015a). With respect to acoustically-induced stress, this includes not only determining how and to what degree various types of anthropogenic sound cause stress in marine mammals, but what factors can mitigate those responses. Factors potentially affecting an animal's response to a stressor include the mammal's life history stage, sex, age, reproductive status, overall physiological and behavioral plasticity, and whether they are naïve or experienced with the sound [e.g., prior experience with a stressor may result in a reduced response due to habituation (Finneran & Branstetter, 2013; St. Aubin & Dierauf, 2001)]. Because there are many unknowns regarding the occurrence of acoustically-induced stress responses in marine mammals, the Navy assumes in its effect analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

Marine mammals naturally experience stressors within their environment and as part of their life histories. Changing weather and ocean conditions, exposure to disease and naturally occurring toxins, lack of prey availability, and interactions with predators all contribute to the stress a marine mammal experiences (Atkinson et al., 2015). Breeding cycles, periods of fasting, social interactions with members of the same species, and molting (for pinnipeds) are also stressors, although they are natural components of an animal's life history. Anthropogenic activities have the potential to provide additional stressors beyond those that occur naturally (Fair et al., 2014; Meissner et al., 2015; Rolland et al., 2012). Anthropogenic stressors potentially include such things as fishery interactions, pollution, tourism, and ocean noise.

The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor (Moberg & Mench, 2000). However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). The generalized stress response is classically characterized by the release of cortisol, a hormone that has many functions including elevation of blood sugar, suppression of the immune system, and alteration of the biochemical pathways that affect fat, protein, and carbohydrate metabolism. However, it is now known that the endocrine response (glandular secretions of hormones into the blood) to a stressor can extend to other hormones. For instance, thyroid hormones can also vary under the influence of certain stressors, particularly food deprivation. These types of responses typically occur on the order of minutes to days. The "fight or flight" response, an acute stress response, is characterized by the very rapid release of hormones that stimulate glucose release, increase heart rate, and increase oxygen consumption.

What is known about the function of the various stress hormones is based largely upon observations of the stress response in terrestrial mammals. The endocrine response of marine mammals to stress may not be the same as that of terrestrial mammals because of the selective pressures marine mammals faced during their evolution in an ocean environment (Atkinson et al., 2015). For example, due to the

necessity of breath-holding while diving and foraging at depth, the physiological role of the epinephrine and norepinephrine (the catecholamines) may have changed. Catecholamines increase during breath-hold diving in seals, co-occurring with a reduction in heart rate, peripheral vasoconstriction (constriction of blood vessels), and an increased reliance on anaerobic metabolism during extended dives (Hance et al., 1982; Hochachka et al., 1995; Hurford et al., 1996); the catecholamine increase is not associated with an increased heart rate, glycemic release, and increased oxygen consumption typical of terrestrial mammals. Other hormone functions may also be different, such as aldosterone, which has been speculated to not only contribute to electrolyte balance, but possibly also the maintenance of blood pressure during periods of vasoconstriction (Houser et al., 2011). In marine mammals, aldosterone is thought to play a particular role in stress mediation because of its noted response to handling stress (St. Aubin & Geraci, 1989; St. Aubin & Dierauf, 2001).

Relatively little information exists on the linkage between anthropogenic sound exposure and stress in marine mammals, and even less information exists on the ultimate consequences of sound-induced stress responses (either acute or chronic). Most studies to date have focused on acute responses to sound either by measuring catecholamines or by measuring heart rate as an assumed proxy for an acute stress response. Belugas demonstrated no catecholamine response to the playback of oil drilling sounds (Thomas et al., 1990b) but showed a small but statistically significant increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al., 2004). A bottlenose dolphin exposed to the same seismic water gun signals did not demonstrate a catecholamine response, but did demonstrate a statistically significant elevation in aldosterone (Romano et al., 2004), albeit the increase was within the normal daily variation observed in this species (St. Aubin et al., 1996). Increases in heart rate were observed in bottlenose dolphins to which known calls of other dolphins were played, although no increase in heart rate was observed when background tank noise was played back (Miksis et al., 2001). Unfortunately, in this study, it cannot be determined whether the increase in heart rate was due to stress or an anticipation of being reunited with the dolphin to which the vocalization belonged. Similarly, a young beluga's heart rate was observed to increase during exposure to noise, with increases dependent upon the frequency band of noise and duration of exposure, and with a sharp decrease to normal or below normal levels upon cessation of the exposure (Lyamin et al., 2011). However, this response may have been in part due to the conditions during testing and the young age of the animal, and therefore heart rate may not be a good predictor of a stress response in cetaceans. Along the same lines, a young, recently captured beluga whale exposed to broadband high frequency noise demonstrated a two-stage heart rate response, with an initial tachycardia (increased heart rate) followed by a decreased heart rate (Bakhchina et al., 2017). However, a year later the exposure was repeated at a slightly higher received level and there was no heart rate response, indicating the beluga whale had likely acclimated to its surroundings and was familiar with this type of noise. Kvadsheim et al. (2010) measured the heart rate of captive hooded seals during exposure to sonar signals, and found an increase in the heart rate of the seals during exposure periods vs. control periods when the animals were at the surface. When the animals dove, the normal dive-related bradycardia (decrease in heart rate) was not impacted by the sonar exposure. Similarly, Thompson et al. (1998) observed a rapid but short-lived decrease in heart rates in harbor and grey seals exposed to seismic air guns (cited in Gordon et al., 2003). Williams et al. (2017) found a non-linear increase in oxygen consumption with both stroke rate and heart rate in swimming and diving bottlenose dolphins, and found that the average energy expended per stroke increased from 2.81 J/kg/stroke during preferred swim speeds to a maximum cost of 6.41 J/kg/stroke when freely following a boat. Collectively, these results demonstrate the difficulty in interpreting the sparse amount of available information on acute stress responses to sound in marine mammals.

Whereas a limited amount of work has addressed the potential for acute sound exposures to produce a stress response, almost nothing is known about how chronic exposure to acoustic stressors affect stress hormones in marine mammals, particularly as it relates to survival or reproduction. In what is probably the only study of chronic noise exposure associating changes in a stress hormone with changes in anthropogenic noise, Rolland et al. (2012) compared the levels of cortisol metabolites in North Atlantic right whale feces collected before and after September 11, 2001. Following the events of September 11, shipping was significantly prohibited in the region where fecal collections were made and regional ocean background noise declined. Fecal cortisol metabolites significantly decreased during the period of reduced ship traffic and ocean noise (Rolland et al., 2012). Considerably more work has been conducted in an attempt to determine the potential effect of boating on smaller cetaceans, particularly killer whales (Bain, 2002; Erbe, 2002; Lusseau, 2006; Noren et al., 2009; Pirotta et al., 2015b; Read et al., 2014; Rolland et al., 2012; Williams et al., 2006; Williams et al., 2009; Williams et al., 2014a; Williams et al., 2014b). Most of these efforts focused primarily on estimates of metabolic costs associated with altered behavior or inferred consequences of boat presence and noise, but did not directly measure stress hormones. However, Ayres et al. (2012) investigated Southern Resident killer whale fecal thyroid hormone and cortisol metabolites to assess two potential threats to the species recovery: lack of prey (salmon) and impacts from exposure to the physical presence of vessel traffic (but without measuring vessel traffic noise). Ayres et al. (2012) concluded from these stress hormone measures that the lack of prey overshadowed any population-level physiological impacts on Southern Resident killer whales due to vessel traffic. Collectively, these studies indicate the difficulty in teasing out factors that are dominant in exerting influence on the secretion of stress hormones, including the separate and additive effects of vessel presence and vessel noise. Nevertheless, although the reduced presence of the ships themselves cannot be ruled out as potentially contributing to the reduction in fecal cortisol metabolites in North Atlantic right whales, the work of Rolland et al. (2012) represents the most provocative link between ocean noise and cortisol in cetaceans to date.

Navy-funded efforts are underway to try and improve our understanding and ability to predict how stressors ultimately affect marine mammal populations (King et al., 2015; e.g., New et al., 2013a; New et al., 2013b; Pirotta et al., 2015a), and whether they are naïve or experienced with the sound (e.g., prior experience with a stressor) may result in a reduced response due to habituation (St. Aubin & Dierauf, 2001)).

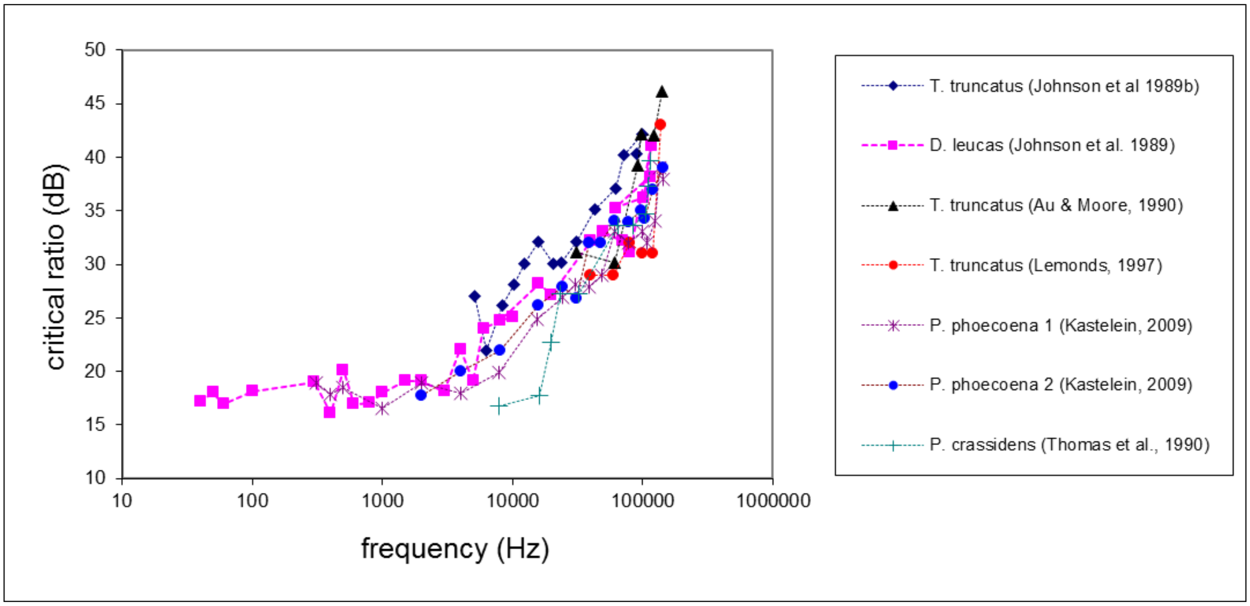
6.4.1.4 Masking

Masking occurs when one sound, distinguished as the “noise”, interferes with the detection or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection or discrimination threshold is raised in the presence of a masker (Erbe et al., 2015). As discussed in Section 6.2 (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities), masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise. Masking can lead to vocal (e.g., Lombard effect, or increasing amplitude or changing frequency) and behavior changes (e.g., cessation of foraging, leaving an area) to both signalers and receivers, in an attempt to compensate for noise levels (Erbe et al., 2015).

Critical ratios are the lowest signal-to-noise ratio in which detection occurs (Finneran & Branstetter, 2013; Johnson et al., 1989; Southall et al., 2000). When expressed in dB, critical ratios can easily be calculated by subtracting the noise level (in dB re 1 μPa^2/Hz) from the signal level (in dB re 1 μPa) at

threshold. Critical ratios have been measured for pinnipeds (Southall et al., 2000, 2003), odontocetes (from Finneran & Branstetter, 2013)

Figure 6-4) (Au & Moore, 1990; Johnson et al., 1989; Kastelein & Wensveen, 2008; Lemonds et al., 2011; Thomas et al., 1990a), manatees (Gaspard et al., 2012), and sea otters (Ghoul & Reichmuth, 2014). Critical ratios are directly related to the bandwidth of auditory filters and as a result, critical ratios increase as a function of signal frequency (Au & Moore, 1990; Lemonds et al., 2011). Higher frequency noise is more effective at masking higher frequency signals. Although critical ratios are typically estimated in controlled laboratory conditions using Gaussian (white) noise, critical ratios can vary considerably depending on the noise type (Branstetter et al., 2013; Trickey et al., 2010).



(from Finneran & Branstetter, 2013)

Figure 6-4: Critical Ratios (in dB) Measured in Different Odontocetes Species

Clark et al. (2009) developed a method for estimating masking effects on communication signals for low-frequency cetaceans, including calculating the cumulative impact of multiple noise sources. For example, their technique calculates that a right whale's optimal communication space (around 20 km) is decreased by 84 percent when two commercial ships pass through it. Similarly, Aguilar de Soto et al. (2006) found that a 15 dB increase in background noise due to vessels led to a communication range of only 18 percent of its normal value for foraging beaked whales. This method relies on empirical data on source levels of calls (which is unknown for many species) and requires many assumptions such as pre-industrial ambient noise conditions and simplifications of animal hearing and behavior, but it is an important step in determining the impact of anthropogenic noise on animal communication. Erbe (2015) developed a model with a noise source-centered view of masking to examine how a call may be masked from a receiver by a noise as a function of caller, receiver, and noise-source location, distance relative to each other and received level of the call.

Vocal changes in response to anthropogenic noise can occur across the repertoire of sound production modes used by marine mammals, such as whistling, echolocation click production, calling, and singing. Vocalization changes may result from a need to compete with an increase in background noise and

include increasing the source level, modifying the frequency, increasing the call repetition rate of vocalizations, or ceasing to vocalize in the presence of increased noise (Hotchkin & Parks, 2013). In cetaceans, vocalization changes were reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying (Gordon et al., 2003; Holt et al., 2008; Holt et al., 2011; Lesage et al., 1999; McDonald et al., 2009; Rolland et al., 2012) as well as changes in the natural acoustic environment (Dunlop et al., 2014). Vocal changes can be temporary, or can be permanent, as seen in the increase in starting frequency for the North Atlantic right whale upcall over the last fifty years (Tennessen & Parks, 2016) This shift in frequency was modeled, and it was found that it lead to increase detection ranges between right whales; the frequency shift, coupled with an increase in call intensity by 20 dB, led to a call detectability range of less than 3 km to over 9 km (Tennessen & Parks, 2016). In some cases, these vocal changes may have fitness consequences, such as an increase in metabolic rates and oxygen consumption, as was found for bottlenose dolphins when increasing their call amplitude (Holt et al., 2015). A switch from vocal communication to physical, surface-generated sounds such as pectoral fin slapping or breaching was observed for humpback whales in the presence of increasing natural background noise levels, indicating that adaptations to masking may also move beyond vocal modifications (Dunlop et al., 2010). These changes all represent possible tactics by the sound-producing animal to reduce the impact of masking. The receiving animal can also reduce masking by using active listening strategies such as orienting to the sound source, moving to a different location to improve binaural cues (time or intensity differences between the ears due to a sound source's location relative to the animal's head), or going still to reduce noise associated with hydrodynamic flow. The structure of some noises (e.g., amplitude modulation) may also provide some release from masking through comodulation masking release (the difference in masking when a noise is broadband versus having the same bandwidth as the signal) (Branstetter & Finneran, 2008; Branstetter et al., 2013). Signal characteristics (e.g., whether the signal has harmonics, or is frequency modulated) may further enhance the detectability of a signal in noise (Cunningham et al., 2014).

Evidence suggests that at least some marine mammals have the ability to acoustically identify potential predators (Allen et al., 2014; Cummings & Thompson, 1971; Curé et al., 2015; Fish & Vania, 1971), which may be reduced in the presence of a masking noise, particularly if it occurs in the same frequency band. Therefore, the occurrence of masking may prevent marine mammals from responding to the acoustic cues produced by their predators. Whether this is a possibility depends on the duration of the masking and the likelihood of encountering a predator during the time that detection and identification of predator cues are impeded. For example, harbor seals that reside in the coastal waters off British Columbia are frequently targeted by certain groups of killer whales. The seals discriminate between the calls of threatening and non-threatening killer whales (Deecke et al., 2002), a capability that should increase survivorship while reducing the energy required to attend to all killer whale calls. Similarly, sperm whales (Isojunno et al., 2016), long-finned pilot whales (Visser et al., 2016), and humpback whales (Curé et al., 2015) changed their behavior in response to killer whale vocalization playbacks; these findings indicating that some recognition of predator cues could be missed if the killer whale vocalizations were masked.

6.4.1.4.1 Masking as a Result of Impulsive Noise

Masking could occur in mysticetes due to the overlap between their low-frequency vocalizations and the dominant frequencies of air gun pulses, however, masking in odontocetes or pinnipeds is less likely unless the seismic survey activity is in close range when the pulses are more broadband. For example, differential vocal responses in marine mammals were documented in the presence of seismic survey noise. An overall decrease in vocalizations during active surveying was noted in large marine mammal

groups (Potter et al., 2007), while blue whale feeding/social calls increased when seismic exploration was underway (Di Lorio & Clark, 2010), indicative of a possible compensatory response to the increased noise level. Bowhead whales were found to increase call rates in the presence of seismic air gun noise at lower received levels (below 100 dB re: 1 μPa^{2}s cumulative SEL), but once the received level rose above 127 dB re 1 μPa^{2}s cumulative SEL the call rate began decreasing, and stopped altogether once received levels reached 170 dB re 1 μPa^{2}s cumulative SEL (Blackwell et al., 2015). Nieukirk et al. (2012) recorded both seismic surveys and fin whale 20 Hz calls at various locations around the mid-Atlantic Ocean, and hypothesized that distant seismic noise could mask those calls thereby decreasing the communication range of fin whales, whose vocalizations may propagate over 400 km to reach conspecifics (Spiesberger & Fristrup, 1990). A spotted and ringed seal in captivity were exposed to seismic air gun sounds recorded within 1 km and 30 km of an air gun survey conducted in shallow (<40 m) water. They were then tested on their ability to detect a 500 ms upsweep centered at 100 Hz at different points in the air gun pulse (start, middle, and end). Based on these results, a 100 Hz vocalization with a source level of 130 dB re 1 μPa would not be detected above a seismic survey 1 km away unless the animal was within 1-5 m, and would not be detected above a survey 30 km away beyond 46 m (Sills et al., 2017).

6.4.1.4.2 Masking as a Result of Sonar and Other Transducers

Masking as a result of duty-cycled low-frequency or mid-frequency active sonar with relatively low duty cycles is unlikely for most cetacean and pinnipeds, as sonar tones occur over a relatively short duration and narrow bandwidth that does not overlap with vocalizations for most marine mammal species. While dolphin vocalizations can occur in the same bandwidth as mid-frequency active sonar, the duty cycle of most low-frequency and mid-frequency active sonars are low enough that delphinid whistles might be masked only a small percentage of the time they are whistling, and so masking by sonar would not likely have any short- or long-term consequences. Low-frequency active sonar could also overlap with mysticete vocalizations (e.g., minke and humpback whales). For example, in the presence of low-frequency active sonar, humpback whales were observed to increase the length of their songs (Fristrup et al., 2003; Miller et al., 2000), possibly due to the overlap in frequencies between the whale song and the low-frequency active sonar.

Newer high duty cycle or continuously active sonars also have more potential to mask vocalizations, particularly for delphinids and other mid-frequency cetaceans. These sonars transmit more frequently (greater than 80 percent duty cycle) than traditional sonars, but at a substantially lower source level. Similarly, high frequency acoustic sources such as pingers that operate at higher repetition rates (e.g., 2-10 kHz with harmonics up to 19 kHz, 76–77 pings per minute (Culik et al., 2001), also operate at lower source levels. While the lower source levels of these systems limits the range of impact compared to more traditional systems, animals close to the sonar source are likely to experience masking on a much longer time scale than those exposed to traditional sonars. The frequency range at which high duty cycle systems operate overlaps the vocalization frequency of a number of mid-frequency cetaceans. Continuous noise at the same frequency of communicative vocalizations may cause disruptions to communication, social interactions, and acoustically-mediated cooperative behaviors such as foraging or reproductive activities. Similarly, because the systems are mid-frequency, there is the potential for the sonar signals to mask important environmental cues like predator vocalizations (e.g., killer whales), possibly affecting survivorship for targeted animals. While there are currently no available studies of the impacts of high duty cycle sonars on marine mammals, masking due to these systems is likely analogous to masking produced by other continuous sources (e.g., vessel noise and low-frequency cetaceans), and will likely have similar short-term consequences, though longer in duration due to the duration of the

masking noise. These may include changes to vocalization amplitude and frequency (Brumm & Slabbekoorn, 2005; Hotchkin & Parks, 2013) and behavioral impacts such as avoidance of the area and interruptions to foraging or other essential behaviors (Gordon et al., 2003). Long-term consequences could include changes to vocal behavior and vocalization structure (Foote et al., 2004; Parks et al., 2007), abandonment of habitat if masking occurs frequently enough to significantly impair communication (Brumm & Slabbekoorn, 2005), a potential decrease in survivorship if predator vocalizations are masked (Brumm & Slabbekoorn, 2005), and a potential decrease in recruitment if masking interferes with reproductive activities or mother-calf communication (Gordon et al., 2003).

6.4.1.4.3 Masking as a Result of Vessel and Vibratory Pile Driving Noise

Masking is more likely to occur in the presence of broadband, relatively continuous noise sources such as vessels and vibratory pile driving. For example, right whales were observed to shift the frequency content of their calls upward while reducing the rate of calling in areas of increased anthropogenic noise (Parks et al., 2007) as well as increasing the amplitude (intensity) of their calls (Parks, 2009; Parks et al., 2011). Right whales also had their communication space reduced by up to 84 percent in the presence of vessels (Clark et al., 2009). Although humpback whales did not change the frequency or duration of their vocalizations in the presence of ship noise, their source levels were lower than expected based on source level changes to wind noise, potentially indicating some signal masking (Dunlop, 2016).

Multiple delphinid species have also been shown to increase the minimum or maximum frequencies of their whistles in the presence of anthropogenic noise (Papale et al., 2015). More specifically, Williams et al. (2014a) found that in median noise conditions in Haro Strait, killer whales lose 62 percent of their acoustic communication space due to vessel traffic noise, and in peak traffic hours lose up to 97 percent of that space. Holt et al. (2008; 2011) showed that Southern Resident killer whales in the waters surrounding the San Juan Islands increased their call source level as vessel noise increased. Hermannsen et al. (2014) estimated that broadband vessel noise could extend up to 160 kHz at ranges from 60–1200 m, and that the higher frequency portion of that noise might mask harbor porpoise clicks. However, this may not be an issue as harbor porpoises may avoid vessels and so may not be close enough to have their clicks masked (Dyndo et al., 2015; Polacheck & Thorpe, 1990; Sairanen, 2014). Furthermore, Hermannsen et al. (2014) estimated that a 6 dB elevation in noise would decrease the hearing range of a harbor porpoise by 50 percent, and a 20 dB increase in noise would decrease the hearing range by 90 percent. Dugong vocalizations were recorded in the presence of passing boats, and although the call rate, intensity or frequency of the calls did not change, the duration of the vocalizations was increased, as was the presence of harmonics. This may indicate more energy was being used to vocalize in order to maintain the same received level (Ando-Mizobata et al., 2014). Gervaise et al. (2012) estimated that beluga whales in the St. Lawrence Marine Park had their estimated communication space under typical background noise conditions already reduced to 30 percent due to vessel traffic, which was further reduced to only 15 percent of their communication space during peak vessel traffic hours coinciding with the arrival and departure of whale watching vessels. Lesage et al. (1999) found belugas in the St. Lawrence River estuary to reduce overall call rates but increase the production of certain call types when ferry and small outboard motor boats were approaching, and to increase the vocalization frequency band when vessels were in close proximity.

Vibratory pile driving noise is a continuous, broadband noise source similar to vessel noise. Wang et al. (2014) found that whistles of humpback dolphins could be masked by a very large vibration pile driving hammer within 200 m, but clicks would not be masked.

6.4.1.5 Behavioral Reactions

As discussed in the Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities (Section 6.2**Error! Reference source not found.**), any stimuli in the environment can cause a behavioral response in marine mammals. These stimuli include noise from anthropogenic sources such as vessels, sonar, air guns, or pile driving, but could also include the physical presence of a vessel or aircraft. However, these stimuli could also influence how or if a marine mammal responds to a sound such as the presence of predators, prey, or conspecifics. Furthermore, the response of a marine mammal to an anthropogenic sound may depend on the frequency, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and their behavioral state (i.e., what the animal is doing and their energetic needs at the time of the exposure) (Ellison et al., 2011). The distance from the sound source and whether it is approaching or moving away can also affect the way an animal responds to a sound (Wartzok et al., 2003).

For marine mammals, a review of responses to anthropogenic sound was first conducted by Richardson et al. (1995). Other reviews (Gomez et al., 2016; Nowacek et al., 2007a; Southall et al., 2007) addressed studies conducted since 1995 and focused on observations where the received sound level of the exposed marine mammal(s) was known or could be estimated, and also examined the role of context. Southall et al. (2007) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general, the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal's experience, motivation, and conditioning were also critical factors influencing the response (Southall et al., 2007; Southall et al., 2016). Ellison et al. (2011) outlined an approach to assessing the effects of sound on marine mammals that incorporates these contextual-based factors. They recommend considering not just the received level of sound, but also in what activity the animal is engaged, the nature and novelty of the sound (i.e., is this a new sound from the animal's perspective), and the distance between the sound source and the animal. They submit that this "exposure context," as described, greatly influences the type of behavioral response exhibited by the animal (see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017c). Forney et al. (2017) also point out that an apparent lack of response (e.g. no displacement or avoidance of a sound source) may not necessarily mean there is no cost to the individual or population, as some resources or habitats may be of such high value that animals may choose to stay, even when experiencing stress or hearing loss. (Forney et al., 2017) recommend considering both the costs of remaining in an area of noise exposure such as TTS, PTS or masking, which could lead to an increased risk of predation or other threats or a decreased capability to forage, and the costs of displacement, including potential increased risk of vessel strike or bycatch, increased risks of predation or competition for resources, or decreased habitat suitable for foraging, resting, or socializing.

Behavioral reactions could result from a variety of sound sources, including impulsive sources such as explosives, air guns, and impact pile driving, and non-impulsive sources such as sonar and other active acoustic sources (e.g., pingers), and vessel and aircraft noise. For some of these noise sources numerous studies exist (e.g., sonar), whereas for others the data are sparse (e.g., pile driving), and surrogate sound sources must be relied upon to assess the potential for behavioral response. Similarly, there is data on the reactions of some species in different behavioral states, providing evidence on the importance of context in gauging a behavioral response. However, for most species, little or no data exist on behavioral responses to any sound source, and so all species have been grouped into broad taxonomic groups from which general response information can be inferred (see technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017c).

6.4.1.5.1 Behavioral Reactions to Impulsive Sound Sources

Impulsive signals, particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle responses or avoidance responses. However, at long distances the rise time increases as the signal duration lengthens (similar to a "ringing" sound), making the impulsive signal more similar to a non-impulsive signal. Data on behavioral responses to impulsive sound sources are limited across all marine mammal groups, with only a few studies available for mysticetes, odontocetes, and pinnipeds. Most data have come from seismic surveys that occur over long durations (e.g., on the order of days to weeks), and typically utilize large multi-air gun arrays that fire repeatedly. While seismic data provide the best available science for assessing behavioral responses to impulsive sounds by marine mammals, it is likely that these responses represent a worst-case scenario as compared to responses to Navy impulsive sources analyzed in this document such as single air guns and small, short-duration pile driving activities.

6.4.1.5.1.1 Mysticetes

Baleen whales have shown a variety of responses to impulsive sound sources, including avoidance, attraction to the source, reduced surface intervals, altered swimming behavior, and changes in vocalization rates (Gordon et al., 2003; McCauley et al., 2000; Richardson et al., 1995; Southall et al., 2007). Studies have been conducted on many baleen whale species, including gray, humpback, blue, fin and bowhead whales; it is assumed that these responses are representative of all baleen whale species. The behavioral state of the whale seems to be an integral part of whether or not the animal responds and how they respond, as does the location and movement of the sound source, more than the received level of the sound.

Migratory behavior seems to lead to a higher likelihood of response, with some species demonstrating more sensitivity than others do. For example, migrating gray whales showed avoidance responses to seismic vessels at received levels between 164 and 190 dB re 1 µPa (Malme et al., 1986, 1988). Similarly, migrating humpback whales showed avoidance behavior at ranges of 5–8 km from a seismic array during observational studies and controlled exposure experiments in one Australian study (McCauley et al., 1998), and in another Australian study decreased their dive times and reduced their swimming speeds (Dunlop et al., 2015). However, when comparing received levels and behavioral responses when using ramp-up versus a constant noise level of air guns, humpback whales did not change their dive behavior but did deviate from their predicted heading and decreased their swim speeds (Dunlop et al., 2016). In addition, the whales demonstrated more course deviation during the constant source trials but reduced travel speeds more in the ramp-up trials; in either case there was no dose-response relationship with the received level of the air gun noise, and similar responses were observed in control trials with vessel movement but no air guns so some of the response was likely due to the presence of the vessel and not the received level of the air guns. McDonald et al. (1995) tracked a blue whale with seafloor seismometers and reported that it stopped vocalizing and changed its travel direction at a range of 10 km from the seismic vessel (estimated received level 143 dB re 1 µPa peak-to-peak). Bowhead whales seem to be the most sensitive species, perhaps due to a higher overlap between bowhead whale distribution and seismic surveys in Arctic and sub-Arctic waters, as well as a recent history of being hunted. While most bowhead whales did not show active avoidance until within 8 km of seismic vessels (Richardson et al., 1995), some whales avoided vessels by more than 20 km at received levels as low as 120 dB re 1 µPa. Additionally, Malme et al. (1988) observed clear changes in diving and breathing patterns in bowheads at ranges up to 73 km from seismic vessels, with received levels as low as 125 dB re 1 µPa. Bowhead whales may also avoid the area around seismic surveys, from 6–8 km (Koski and Johnson 1987, as cited in Gordon et al., 2003) out to 20 or 30 km (Richardson et al., 1999).

However, work by Robertson (2014) supports the idea that behavioral responses are contextually dependent, and that during seismic operations bowhead whales may be less "available" for counting due to alterations in dive behavior but that they may not have left the area after all.

In contrast, noise from seismic surveys was not found to impact feeding behavior or exhalation rates in western gray whales while resting or diving off the coast of Russia (Gailey et al., 2007; Yazvenko et al., 2007). However, the increase in vessel traffic associated with the surveys and the proximity of the vessels to the whales did effect the orientation of the whales relative to the vessels and shortened their dive-surface intervals (Gailey et al., 2016). Todd et al. (1996) found no clear short-term behavioral responses by foraging humpbacks to explosions associated with construction operations in Newfoundland but did see a trend of increased rates of net entanglement closer to the noise source, possibly indicating a reduction in net detection associated with the noise through masking or TTS. Distributions of fin and minke whales were modeled with a suite of environmental variables along with the occurrence or absence of seismic surveys, and no evidence of a decrease in sighting rates relative to seismic activity was found for either species (Vilela et al., 2016). Their distributions were driven entirely by environmental variables, particularly those linked to prey including warmer sea surface temperatures, higher chlorophyll-a values, and higher photosynthetically available radiation (a measure of primary productivity).

Vocal responses to seismic surveys have been observed in a number of baleen whale species, including a cessation of calling, a shift in frequency, increases in amplitude or call rate, or a combination of these strategies. Blue whale feeding/social calls were found to increase when seismic exploration was underway, with seismic pulses at average received SELs of 131 dB re 1 μPa^2s (Di Lorio & Clark, 2010), a potentially compensatory response to increased noise level. Responses by fin whales to a 10-day seismic survey in the Mediterranean Sea included possible decreased 20-Hz call production and movement of animals from the area based on lower received levels and changes in bearings (Castellote et al., 2012). However, similarly distant seismic surveys elicited no apparent vocal response from fin whales in the mid-Atlantic Ocean; instead, Nieukirk et al. (2012) hypothesized that 20-Hz calls may have been masked from the receiver by distant seismic noise. Models of humpback whale song off Angola showed significant seasonal and diel variation, but also showed a decrease in the number of singers with increasing received levels of air gun pulses (Cerchio et al., 2014). Bowhead whale calling rates decreased significantly at sites near seismic surveys (41–45 km) where median received levels were between 116–129 dB re 1 μPa, and did not decrease at sites further from the seismic surveys (greater than 104 km) where median received levels were 99–108 dB re 1 μPa (Blackwell et al., 2013). In fact, bowhead whale calling rates increased at the lower received levels, began decreasing at around 127 dB re 1 μPa^2s cumulative SEL, and ceased altogether at received levels over 170 dB re 1 μPa^2s cumulative SEL (Blackwell et al., 2015).

Mysticetes seem to be the most sensitive taxonomic group of marine mammals to impulsive sound sources, with possible avoidance responses occurring out to 30 km and vocal changes occurring in response to sounds over 100 km away. However, responses appear to be behaviorally mediated, with most avoidance responses occurring during migration behavior and little observed response during feeding behavior. These response patterns are likely to hold true for Navy impulsive sources; however, Navy impulsive sources would largely be stationary (e.g., pile driving), short term (on the order of hours rather than days or weeks), and lower source level (e.g., air guns) than were found in these studies and so responses would likely occur in closer proximity or not at all.

6.4.1.5.1.2 Odontocetes

Few data are available on odontocete responses to impulsive sound sources, with only a few studies on responses to seismic surveys, pile driving and construction activity available. However, odontocetes appear to be less sensitive to impulsive sound than mysticetes, with responses occurring at much closer distances. This may be due to the predominance of low-frequency sound associated with these sources that propagates long distances and overlaps with the range of best hearing for mysticetes but is below that range for odontocetes. The exception to this is the harbor porpoise, which has been shown to be highly sensitive to most sound sources, avoiding both stationary (e.g., pile driving) and moving (e.g., seismic survey vessels) impulsive sound sources out to approximately 20 km (e.g., Haelters et al., 2014; Pirotta et al., 2014). However, even this response is short-term, with porpoises returning to the area within hours after the cessation of the noise.

Madsen et al. (2006a) and Miller et al. (2009) tagged and monitored eight sperm whales in the Gulf of Mexico exposed to seismic air gun surveys. Sound sources were from approximately 2 to 7 NM away from the whales, and received levels were as high as 162 dB SPL re 1 µPa (Madsen et al., 2006). The whales showed no horizontal avoidance, however one whale rested at the water's surface for an extended period of time until air guns ceased firing (Miller et al., 2009). While the remaining whales continued to execute foraging dives throughout exposure, tag data suggested there may have been subtle effects of noise on foraging behavior (Miller et al., 2009). Similarly, Weir (2008) observed that seismic air gun surveys along the Angolan coast did not significantly reduce the encounter rate of sperm whales during the 10-month survey period, nor were avoidance behaviors to air gun impulsive sounds observed. In contrast, Atlantic spotted dolphins did show a significant, short-term avoidance response to air gun impulses within approximately 1 km of the source (Weir, 2008). The dolphins were observed at greater distances from the vessel when the air gun was in use, and when the air gun was not in use they readily approached the vessel to bow ride.

Captive bottlenose dolphins sometimes vocalized or were reluctant to return to the test station after exposure to single impulses from a seismic water gun (Finneran et al., 2002). When exposed to multiple impulses from a seismic air gun, some dolphins turned their heads away from the sound source just before the impulse, showing that they could anticipate the timing of the impulses and perhaps reduce the received level (Finneran et al., 2015). During construction (including the blasting of old bastions) of a bridge over a waterway commonly used by the Tampa Bay, FL stock of bottlenose dolphins, the use of the area by females decreased while males displayed high site fidelity and continued using the area, perhaps indicating differential habitat uses between the sexes (Weaver, 2015).

A study was conducted on the response of harbor porpoises to a seismic survey using aerial surveys and C-PODs (an autonomous recording device that counts odontocete clicks); the animals appeared to have left the area of the survey, and decreased their foraging activity within 5–10 km, as evidenced by both a decrease in vocalizations near the survey and an increase in vocalizations at a distance (Pirotta et al., 2014; Thompson et al., 2013). However, the animals returned within a day after the air gun operation ceased, and the decrease in occurrence over the survey period was small relative to the observed natural seasonal decrease compared to the previous year. A number of studies (Brandt et al., 2011; Dähne et al., 2014; Haelters et al., 2014; Thompson et al., 2010; Tougaard et al., 2005; Tougaard et al., 2009) also found strong avoidance responses by harbor porpoises out to 20 km during pile driving; however, all studies found that the animals returned to the area after the cessation of pile driving. Kastelein et al. (2013b) exposed a captive harbor porpoise to impact pile driving sounds, and found that above 136 dB re 1 µPa (zero-to-peak) the animal's respiration rates increased, and at higher levels it

jumped more frequently. Bergstrom et al. (2014) found that although there was a high likelihood of acoustic disturbance during wind farm construction (including pile driving), the impact was short-term. Graham et al. (2017) assessed the occurrence of bottlenose dolphins and harbor porpoises over different area and time scales with and without impact and vibratory pile driving. While there were fewer hours with bottlenose dolphin detections and reduced detection durations within the pile driving area and increased detection durations outside the area, the effects sizes were small, and the reduced harbor porpoise encounter duration was attributed to seasonal changes outside the influence of the pile driving. However, received levels in this area were lower due to propagation effects than in the other areas described above, which may have led to the lack of or reduced response.

Odontocete behavioral responses to impulsive sound sources are likely species- and context-dependent, with most species demonstrating little to no apparent response. Responses might be expected within close proximity to a noise source, under specific behavioral conditions such as females with offspring, or for sensitive species such as harbor porpoises.

6.4.1.5.1.3 Pinnipeds

A review of behavioral reactions by pinnipeds to impulsive noise can be found in Richardson et al. (1995) and Southall et al. (2007). Blackwell et al. (2004) observed that ringed seals exhibited little or no reaction to pipe-driving noise with mean underwater levels of 157 dB re 1 µPa and in air levels of 112 dB re 20 µPa, suggesting that the seals had habituated to the noise. In contrast, captive California sea lions avoided sounds from an underwater impulsive source at levels of 165–170 dB re 1 µPa (Finneran et al., 2003b). Harbor and grey seals were also observed to avoid a seismic air gun by rapidly swimming away, and ceased foraging during exposure, but returned to normal behavior afterwards (Thompson et al. 1998, cited in Gordon et al., 2003). In another study, few responses were observed by New Zealand fur seals to a towed air gun array operating at full power; rather, when responses were observed it seemed to be to the physical presence of the vessel and tow apparatus, and these only occurred when the vessel was within 200 m and sometimes as close as 5 m (Lalas & McConnell, 2016). Captive Steller sea lions were exposed to a variety of tonal, sweep, impulsive and broadband sounds to determine what might work as a deterrent from fishing nets. The impulsive sound had a source level of 120 dB re 1 µPa at 1 m, and caused the animals to haul out and refuse to eat fish presented in a net (Akamatsu et al., 1996). Steller sea lions exposed to in-air explosive blasts increased their activity levels and often re-entered the water when hauled out (Demarchi et al., 2012). However, these responses were short-lived and within minutes, the animals had hauled out again, and there were no lasting behavioral impacts in the days following the blasts.

Experimentally, Götz & Janik (2011) tested underwater startle responses to a startling sound (sound with a rapid rise time and a 93 dB sensation level [the level above the animal's hearing threshold at that frequency]) and a nonstartling sound (sound with the same level, but with a slower rise time) in wild-captured gray seals. The animals exposed to the startling treatment avoided a known food source, whereas animals exposed to the nonstartling treatment did not react or habituated during the exposure period. The results of this study highlight the importance of the characteristics of the acoustic signal in an animal’s response of habituation.

Pinnipeds may be the least sensitive taxonomic group to most noise sources, although some species may be more sensitive than others, and are likely to only respond to loud impulsive sound sources at close ranges by startling, jumping into the water when hauled out, or even cease foraging, but only for brief periods before returning to their previous behavior (e.g., Southall et al. 2007). Pinnipeds may even

experience TTS (see Section 6.4.1.2, Hearing Loss and Auditory Injury) before exhibiting a behavioral response (Southall et al., 2007).

6.4.1.5.2 Behavioral Reactions to Sonar and other Transducers

Sonar and other transducers can range in frequency from less than 1 kHz (e.g., low-frequency active sonar) to over 200 kHz (e.g., fish finders), with duty cycles that range from one ping per minute to an almost continuous sound. Although very-high-frequency sonars are out of the hearing range of most marine mammals, some of these sources may contain artifacts at lower frequencies that could be detected (Deng et al., 2014; Hastie et al., 2014). High duty-cycle sonar systems operate at lower source levels, but with a more continuous sound output. These sources can be stationary, or on a moving platform, and there can be more than one source present at a time. Guan et al. (2017) also found that sound levels in the mid-frequency sonar bandwidth remained elevated at least 5 dB above background levels for the first 7 – 15 seconds (within 2 km) after the emission of a sonar ping; depending on the length of the sonar ping and the inter-ping interval this reverberation could increase cumulative SEL estimates during periods of active sonar. This variability in parameters associated with sonar and other transducers makes the estimation of behavioral responses to these sources difficult, with observed responses ranging from no apparent change in behavior to more severe responses that could lead to some costs to the animal. As discussed in Section 3.0.3.6.1 of the EIS/OEIS (Conceptual Framework for Assessing Effects from Acoustic and Explosive Activities) and Section 6.4.1.5 (Behavioral Reactions), responses may also occur in the presence of different contextual factors regardless of received level, including the proximity and number of vessels, the behavioral state and prior experience of an individual, and even characteristics of the signal itself or the propagation of the signal through the environment.

In order to explore this complex question, behavioral response studies have been conducted through the collaboration of various research and government organizations in Bahamian, United States (off Southern California), Mediterranean, Australian, and Norwegian waters. These studies have attempted to define and measure responses of beaked whales and other cetaceans to controlled exposures of sonar and other sounds to understand better their potential impacts. While controlling for as many variables as possible (e.g., the distance and movement of the source), these studies also introduce additional variables that do not normally occur in a real Navy training or testing activity, including the tagging of whales, following the tagged animals with multiple vessels, and continually approaching the animal to create a dose escalation. In addition, distances of the sound source from the whales during behavioral response studies were always within 1–8 km. Some of these studies have suggested that ramping-up a source from a lower source level would act as a protective measure to mitigate higher order (e.g., TTS or PTS) impacts of sonar; however, this practice may only be effective for more responsive animals, and for short durations (e.g., 5 min) of ramp-up (Von Benda-Beckmann et al., 2014; von Benda-Beckmann et al., 2016). Therefore, while these studies have provided the most information to date on behavioral responses of marine mammals to sonar, there are still many contextual factors to be teased apart and determining what might produce a significant behavioral response is not a trivial task.

Passive acoustic monitoring and visual observational behavioral response studies have also been conducted on Navy ranges, taking advantage of the existing seafloor hydrophones and real testing and training activity and associated sources to assess behavioral responses (Deakos & Richlen, 2015; Henderson et al., 2016; Manzano-Roth et al., 2016; Martin et al., 2015b; McCarthy et al., 2011; Mobley & Deakos, 2015; Moretti et al., 2014; Tyack et al., 2011). In addition, extensive aerial, visual, and

acoustic monitoring is conducted before, during and after training events to watch for behavioral responses during training and look for injured or stranded animals after training (Farak et al., 2011; HDR, 2011; Norris et al., 2012; Smultea & Mobley, 2009; Smultea et al., 2009; Trickey et al., 2015; U.S. Department of the Navy, 2011a, 2013a, 2014a, 2015a). During all of these monitoring efforts, very few behavioral responses were observed, and no injured or dead animal was observed that was directly related to a training event (some dead animals were observed but typically before the event or appeared to have been deceased prior to the event; e.g., Smultea et al., 2011). While passive acoustic studies are limited to detections of vocally-active marine mammals and visual studies are limited to what can be observed at the surface, these study types have the benefit of occurring in the absence of some of the added contextual variables in the controlled exposure studies. Furthermore, when visual and passive acoustic data collected during a training event are combined with ship movements and sonar use they provide a unique and realistic scenario for analysis. In addition to these types of observational behavioral response studies, Harris & Thomas (2015) highlighted additional research approaches that may provide further information on behavioral responses to sonars and other transducers beyond behavior response type studies or passive acoustic monitoring, including conducting controlled exposures on captive animals with scaled (smaller sized and deployed at closer proximity) sources, on wild animals with both scaled and real but directed sources, and predator playback studies, all of which will be discussed below.

The above behavioral response studies and observations have been conducted on a number of mysticete and odontocete species, which can be extrapolated to other similar species in these taxonomic groups. No field studies of pinniped behavioral responses to sonar have been conducted; however, there are several captive studies on some pinniped and odontocete species that can provide insight into how these animals may respond in the wild. The captive studies typically represent a more controlled approach, which allow researchers to better estimate the direct impact of the received level of sound leading to behavioral responses, and to potentially link behavioral to physiological responses. However, there are still contextual factors that must be acknowledged, including previous training to complete tasks and the presence of food rewards upon completion. There are no corresponding captive studies on mysticete whales, therefore some of the responses to higher level exposures must be extrapolated from odontocetes.

6.4.1.5.2.1 Mysticetes

As with impulsive sounds, the responses of mysticetes to sonar and other duty-cycled tonal sounds are highly dependent upon the characteristics of the signal, the behavioral state of the animal, the particular sensitivity and previous experience of an individual, and other contextual factors including distance of the source, movement of the source, and the physical presence of vessels in addition to the sonar (Goldbogen et al., 2013; Harris et al., 2015; Martin et al., 2015b; Sivle et al., 2015). Behavioral response studies have been conducted over a variety of contextual and behavioral states, helping to identify which contextual factors may lead to a response beyond just the received level of the sound. Observed reactions during behavioral response studies have not been consistent across individuals based on received sound levels alone, and likely were the result of complex interactions between these contextual factors.

Surface feeding blue whales did not show a change in behavior in response to mid-frequency simulated and real sonar sources with received levels between 90 and 179 dB re 1 µPa, but deep feeding and non-feeding whales showed temporary reactions including cessation of feeding, reduced initiation of deep foraging dives, generalized avoidance responses, and changes to dive behavior (DeRuiter et al., 2017;

Goldbogen et al., 2013; Sivle et al., 2015). Similarly, while the rates of foraging lunges decreased in humpback whales due to sonar exposure, there was variability in the response across individuals, with one animal ceasing to forage completely and another animal starting to forage during the exposure (Sivle et al., 2016). In addition, lunges decreased (although not significantly) during a no-sonar control vessel approach prior to the sonar exposure, and lunges decreased less during a second sonar approach than during the initial approach, possibly indicating some response to the vessel and some habituation to the sonar and vessel after repeated approaches. In the same experiment, most of the non-foraging humpback whales did not response to any of the approaches (Sivle et al., 2016). These findings indicate that the behavioral state of the animal plays a role in the type and severity of a behavioral response. In fact, when the prey field was mapped and used as a covariate in similar models looking for a response in blue whales, the response in deep-feeding behavior by blue whales was even more apparent, reinforcing the need for contextual variables to be included when assessing behavioral responses (Friedlaender et al., 2016). However, even when responses did occur the animals quickly returned to their previous behavior after the sound exposure ended (Goldbogen et al., 2013; Sivle et al., 2015). In another study, humpback whales exposed to a 3 kHz pinger meant to act as a net alarm to prevent entanglement did not respond or change course, even when within 500 m (Harcourt et al., 2014). However, five out of six North Atlantic right whales exposed to an acoustic alarm interrupted their foraging dives; in this case, the alarm was comprised of a mixture of signals with frequencies from 500 to 4500 Hz, was long in duration lasting several minutes, and was purposely designed to elicit a reaction from the animals as a prospective means to protect them from ship strikes (Nowacek et al., 2004). Although the animals' received SPL was similar in the latter two studies (133–150 dB re 1 $\mu Pa^2 s$), the frequency, duration, and temporal pattern of signal presentation were different.

Humpback whales in another behavioral response experiment in Australia also responded to a 2 kHz tone stimulus by changing their course during migration to move more offshore and surfaced more frequently, but otherwise did not respond (Dunlop et al., 2013). Humpback whales in the Norwegian behavioral response study may have habituated slightly between the first and second sonar exposure (Sivle et al., 2015), and actually responded more severely to killer whale vocalization playbacks than they did to the sonar playbacks. Several humpback whales have been observed during aerial or visual surveys during Navy training events involving sonar; no avoidance or other behavioral responses were ever noted, even when the whales were observed within 5 km of a vessel with active (or possibly active) sonar and maximum received levels were estimated to be between 135 and 161 dB re 1 µPa (Mobley & Milette, 2010; Mobley, 2011; Mobley & Pacini, 2012; Mobley et al., 2012; Smultea et al., 2009). In fact, one group of humpback whales approached a vessel with active sonar so closely that the sonar was shut-down and the vessel slowed; the animals continued approaching and swam under the bow of the vessel (U.S. Department of the Navy, 2011d). Another group of humpback whales continued heading towards a vessel with active sonar as the vessel was moving away for almost 30 minutes, with an estimated median received level of 143 dB re 1 µPa. This group was observed producing surface active behaviors such as pec slaps, tail slaps and breaches, however these are very common behaviors in competitive pods during the breeding season and were not considered to have occurred in response to the sonar (Mobley et al., 2012).

The strongest baleen whale response in any behavioral response study was observed in a minke whale in the 3S2 study, which responded at 146 dB re 1 µPa by strongly avoiding the sound source (Kvadsheim et al., 2017; Sivle et al., 2015). Although the minke whale increased their swim speed, directional movement and respiration rate, none of these were greater than rates observed in baseline behavior, and their dive behavior remained similar to baseline dives. A minke whale tagged in the SOCAL BRS

study also responded by increasing their directional movement, but maintained their speed and dive patterns, so did not demonstrate as strong of a response(Kvadsheim et al., 2017). In addition, the 3S2 minke whale demonstrated some of the same avoidance behavior during the controlled ship approach with no sonar, indicating at least some of the response was to the vessel (Kvadsheim et al., 2017). Martin et al. (2015b) found that the density of calling minke whales was reduced during periods of Navy training involving sonar relative to the periods before training, and increased again in the days after training was completed. The responses of individual whales could not be assessed, so in this case it is unknown whether the decrease in calling animals indicated that the animals left the range, or simply ceased calling. Similarly, minke whale detections made using Marine Acoustic Recording Instruments off Jacksonville, FL were reduced or ceased altogether during periods of sonar use (Norris et al., 2012; U.S. Department of the Navy, 2013a), especially with an increased ping rate (Charif et al., 2015). Two minke whales also stranded in shallow water after the US Navy training event in the Bahamas in 2000, although these animals were successfully returned to deep water with no physical examinations, therefore no final conclusions were drawn on whether the sonar led to their stranding (Filadelfo et al., 2009a; Filadelfo et al., 2009b; U.S. Department of Commerce & U.S. Department of the Navy, 2001).

Baleen whales have also been exposed to lower frequency sonars, with the hypothesis that these whales may react more strongly to lower frequency sounds that overlap with their vocalization range. One series of studies was undertaken in 1997–1998 pursuant to the Navy's Low-Frequency Sound Scientific Research Program. The frequency bands of the low-frequency sonars used were between 100 and 500 Hz, with received levels between 115 and 150 dB re 1 µPa, and the source was always stationary. Fin and blue whales were targeted on foraging grounds, singing humpback whales were exposed on breeding grounds, and gray whales were exposed during migratory behavior. These studies found only short-term responses to low-frequency sound by some fin and humpback whales, including changes in vocal activity and avoidance of the source vessel, while other fin, humpback, and blue whales did not respond at all. When the source was in the path of migrating gray whales they changed course up to 2 km to avoid the sound, but when the source was outside their path, little response was observed (Clark & Fristrup, 2001; Croll et al., 2001; Fristrup et al., 2003; Miller et al., 2000; Nowacek et al., 2007b). Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source were also not found to affect dive times of humpback whales in Hawaiian waters (Frankel & Clark, 2000).

Opportunistic passive acoustic based studies have also detected behavioral responses to sonar, although definitive conclusions are harder to draw. Blue whales exposed to mid-frequency sonar in the Southern California Bight were less likely to produce low-frequency calls usually associated with feeding behavior, beginning at received levels of 110−120 dB re 1 µPa (Melcón et al., 2012); however, without visual observations it is unknown whether there was another factor that contributed to the reduction in foraging calls, such as the presence of conspecifics. In another example, Risch et al. (2012) determined that humpback whale song produced in the Stellwagen Bank National Marine Sanctuary was reduced, and since the timing was concurrent with an Ocean Acoustic Waveguide Remote Sensing experiment occurring 200 km away, they concluded that the reduced song was a result of the Ocean Acoustic Waveguide Remote Sensing. However, Gong et al. (2014) analyzed the same data set while also looking at the presence of herring in the region, and found that the singing humpbacks were actually located on nearby Georges Bank and not on Stellwagen, and that the song rate in their data did not change in response to Ocean Acoustic Waveguide Remote Sensing, but could be explained by natural causes.

Although some strong responses have been observed in mysticetes to sonar and other active acoustic sources (e.g., the single minke whale), for the most part mysticete responses appear to be fairly

moderate across all received levels. While some responses such as cessation of foraging or changes in dive behavior could carry short-term impacts, in all cases behavior returned to normal after the signal stopped. Mysticete responses also seem to be highly mediated by behavioral state, with no responses occurring in some behavioral states, and contextual factors and signal characteristics having more impact than received level alone. Many of the contextual factors resulting from the behavioral response studies (e.g., close approaches by multiple vessels or tagging) would never be introduced in real Navy testing and training scenarios. While there is a lack of data on behavioral responses of mysticetes to continuously active sonars, these species are known to be able to habituate to novel and continuous sounds (Nowacek et al. 2004), suggesting that they are likely to have similar responses to high duty cycle sonars. Therefore mysticete behavioral responses to Navy sonar will likely be a result of the animal's behavioral state and prior experience rather than external variables such as ship proximity; thus, if significant behavioral responses occur they will likely be short-term. In fact, no significant behavioral responses such as panic, stranding or other severe reactions have been observed during monitoring of actual training exercises (Smultea et al., 2009; U.S. Department of the Navy, 2011a, 2014b; Watwood et al., 2012).

6.4.1.5.2.2 Odontocetes

Behavioral response studies have been conducted on odontocete species since 2007, with a focus on beaked whale responses to active sonar transmissions or controlled exposure playback of simulated sonar on various military ranges (Claridge et al., 2009; Defence Science and Technology Laboratory, 2007; Manzano-Roth et al., 2013; McCarthy et al., 2011; Moretti et al., 2009; Southall et al., 2011; Southall et al., 2012; Southall et al., 2013; Southall et al., 2014; Southall et al., 2015; Tyack et al., 2011). Through analyses of these behavioral response studies, a preliminary overarching effect of greater sensitivity to most anthropogenic exposures was seen in beaked whales compared to the other odontocetes studied (Southall et al., 2009).

Observed reactions by Blainville's, Cuvier's, and Baird's beaked whales to mid-frequency sonar sounds have included cessation of clicking, termination of foraging dives, changes in direction to avoid the sound source, slower ascent rates to the surface, and other unusual dive behavior (Boyd et al., 2008; Defence Science and Technology Laboratory, 2007; DeRuiter et al., 2013b; Miller et al., 2015; Southall et al., 2011; Stimpert et al., 2014; Tyack et al., 2011). A similar response was observed in a northern bottlenose whale, which conducted the longest and deepest dive on record for that species after the sonar exposure and continued swimming away from the source for over 7 hours (Miller et al., 2015). Responses occurred at received levels between 95 and 150 dB re 1 µPa; although all of these exposures occurred within 1–8 km of the focal animal, within a few hours of tagging the animal, and with one or more boats within a few kilometers to observe responses and record acoustic data. One Cuvier's beaked whale was also incidentally exposed to Navy sonar located over 100 km away, and the authors did not detect similar responses at comparable received levels. Received levels from the mid-frequency active sonar signals from the controlled and incidental exposures were calculated as 84–144 and 78–106 dB re 1 µPa, respectively, indicating that context of the exposures (e.g., source proximity, controlled source ramp-up) may have been a significant factor in the responses to the simulated sonars (DeRuiter et al., 2013b). Furthermore, recent long-term tagging work has demonstrated that the longer duration dives considered a behavioral response by DeRuiter et al. (2013b) fell within the normal range of dive durations found for eight tagged Cuvier's beaked whales on the Southern California Offshore Range (Schorr et al., 2014). However, the longer inter-deep dive intervals found by DeRuiter et al. (2013) were among the longest found by Schorr et al. (2014) and could indicate a response to sonar. In addition,

Williams et al. (2017) note that in normal deep dives or during fast swim speeds, beaked whales and other marine mammals use strategies to reduce their stroke rates, including leaping or wave surfing when swimming, and interspersing glides between bouts of stroking when diving. They determined that in the post-exposure dives by the tagged Cuvier's beaked whales described in DeRuiter et al. (2013b), the whales ceased gliding and swam with almost continuous strokes. This change in swim behavior was calculated to increase metabolic costs about 30.5 percent and increase the amount of energy expending on fast swim speeds from 27 to 59 percent of their overall energy budget. This repartitioning of energy was detected in the model up to 1.7 hours after the single sonar exposure. Therefore while the overall post-exposure dive durations were similar, the metabolic energy calculated by WIlliams (2017) was higher.

On Navy ranges, Blainville's beaked whales located on the range appear to move off-range during sonar use and return only after the sonar transmissions have stopped, sometimes taking several days to do so (Claridge et al., 2009; Manzano-Roth et al., 2016; Manzano-Roth et al., 2013; McCarthy et al., 2011; Moretti et al., 2009; Tyack et al., 2011). However, Blainville's beaked whales remain on the range to forage throughout the rest of the year (Henderson et al., 2016), possibly indicating that this a preferred foraging habitat regardless of the effects of the noise, or it could be that there are no long-term consequences of the sonar activity. Similarly, photo identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, with 40 percent having been seen in one or more prior years, with re-sightings up to 7 years apart, indicating a possibly resident population on the range (Falcone et al., 2009; Falcone & Schorr, 2014).

Tyack et al. (2011) hypothesized that beaked whale responses to sonar may represent an anti-predator response. To test this idea, vocalizations of a potential predator—a killer whale—were also played back to a Blainville's beaked whale. This exposure resulted in a similar but more pronounced reaction than that elicited by sonar playback, which included longer inter-dive intervals and a sustained straight-line departure of more than 20 km from the area (Allen et al., 2014; Tyack et al., 2011). This anti-predator hypothesis was also tested by playing back killer whale vocalizations to pilot whales, sperm whales, and even other killer whales, to determine responses by both potential prey and conspecifics (Miller et al., 2011; Miller et al., 2012). Results varied, from no response by killer whales to an increase in group size and attraction to the source in pilot whales (Cure et al., 2012).

While there has been a focus on beaked whale responses to sonar, other species have been studied during behavioral response studies as well, including pilot whales, killer whales, and sperm whales. Responses by these species have also included horizontal avoidance, changes in behavioral state, and changes in dive behavior (Antunes et al., 2014; Miller et al., 2011; Miller et al., 2014; Miller et al., 2012). Additionally, separation of a killer whale calf from its group during exposure to mid-frequency sonar playback was observed (Miller et al., 2011). Received level thresholds at the onset of avoidance behavior were generally higher for pilot whales (mean 150 dB re 1µPa) and sperm whales (mean 140 dB re 1µPa) than killer whales (mean 129 dB re 1µPa) (Antunes et al., 2014; Miller et al., 2014; Miller et al., 2012). A close examination of the tag data from the Norwegian groups showed that responses seemed to be behaviorally or signal frequency mediated. For example, killer whales only changed their dive behavior when doing deep dives at the onset of 1−2 kHz sonar (sweeping across frequencies), but did not change their dive behavior if they were deep diving during 6−7 kHz sonar (sweeping across frequencies). Nor did they change their dive behavior if they were conducting shallow dives at the onset of either type of sonar. Similarly, pilot whales and sperm whales performed normal deep dives during 6-7 kHz sonar, while during 1−2 kHz sonar the pilot whales conducted fewer deep dives and the sperm whales

performed shorter and shallower dives (Sivle et al., 2012b). In addition, pilot whales were also more likely to respond to lower received levels when non-feeding than feeding during 6−7 kHz sonar exposures, but were more likely to respond at higher received levels when non-feeding during 1−2 kHz sonar exposures. Furthermore, pilot whales exposed to a 38 kHz downward-facing echosounder did not change their dive and foraging behavior during exposure periods, although the animals' heading variance increased and fewer deep dives were conducted (Quick et al., 2017). In contrast, killer whales were more likely to respond to either sonar type when non-feeding than when feeding (Harris et al., 2015). These results again demonstrate that the behavioral state of the animal mediates the likelihood of a behavioral response, as do the characteristics (e.g., frequency) of the sound source itself.

Other responses during behavioral response studies included the synchronization of pilot whale surfacings with sonar pulses during one exposure, possibly as a means of mitigating the sound (Wensveen et al., 2015), and mimicry of the sonar with whistles by pilot whales (Alves et al., 2014), false killer whales (DeRuiter et al., 2013b) and Risso's dolphins (Smultea et al., 2012a). In contrast, in another study melon-headed whales had "minor transient silencing" (a brief, non-lasting period of silence) after each 6−7 kHz signal, and (in a different oceanographic region) pilot whales had no apparent response (DeRuiter et al., 2013a). The probability of detecting delphinid vocalizations (whistles, clicks, and buzzes) increased during periods of sonar relative to the period prior to sonar in a passive acoustic study using Marine Autonomous Recording Units in the Jacksonville Range Complex, while there was no impact of sonar to the probability of detecting sperm whale clicks (Charif et al., 2015; U.S. Department of the Navy, 2013b).

In addition, killer whale sighting data from the same region in Norway as the behavioral response study was used to compare the presence or absence of whales from other years against the period with sonar. The authors found a strong relationship between the presence of whales and the abundance of herring, and only a weak relationship between the whales and sonar activity (Kuningas et al., 2013). Baird et al. (2013b; 2014; Baird et al., 2017) also tagged four shallow-diving odontocete species (rough toothed dolphins, pilot whales, bottlenose dolphins, and false killer whales) in Hawaii off the Pacific Missile Range Facility before Navy training events. None of the tagged animals demonstrated a large-scale avoidance response to the sonar as they moved on or near the range, in some cases even traveling towards areas of higher noise levels, while estimated received SPLs varied from 130–168 dB re 1 µPa and distances from sonar sources ranged between 3.2 – 94.4 km. However, one pilot whale did have reduced dive rates (from 2.6 dives per hour before to 1.6 dives per hour during) and deeper dives (from a mean of 124 m to 268 m) during a period of sonar exposure. (Baird et al., 2016) also tagged four short-finned pilot whales from both the resident island-associated population and from the pelagic population. The core range for the pelagic population was over 20 times larger than for the pelagic population, leading (Baird et al., 2016) to hypothesize that that likelihood of exposure to mid-frequency active sonar, and therefore the potential for response, would be very different between the two populations. These diverse examples demonstrate that responses can be varied, are often context- and behaviorally-driven, and can be species and even exposure specific.

Other opportunistic observations of behavioral responses to sonar have occurred as well, although in those cases it is difficult to attribute observed responses directly to the sonar exposure, or to know exactly what form the response took. For example, both sperm and pilot whales potentially ceased sound production during the Heard Island feasibility test, with transmissions centered at 57 Hz and up to 220 dB re1 µPa (Bowles et al., 1994), although it could not be determined whether the animals ceased sound production or left the area. In May 2003, killer whales in Haro Strait, Washington exhibited what

were believed by some observers to be aberrant behaviors, during which time the USS Shoup was in the vicinity and engaged in mid-frequency active sonar operations. Sound fields modeled for the USS Shoup transmissions (Fromm, 2009; National Marine Fisheries Service, 2005; U.S. Department of the Navy, 2003) estimated a mean received SPL of approximately 169 dB re 1µPa at the location of the killer whales at the closest point of approach between the animals and the vessel (estimated SPLs ranged from 150 to 180 dB re 1µPa). However, attributing the observed behaviors to any one cause is problematic given there were six nearby whale watch vessels surrounding the pod, and subsequent research has demonstrated that "Southern Residents modify their behavior by increasing surface activity (breaches, tail slaps, and pectoral fin slaps) and swimming in more erratic paths when vessels are close" (National Oceanic and Atmospheric Administration, 2014). Several odontocete species, including bottlenose dolphins, Risso's dolphins, Pacific white-sided dolphins, and common dolphins have been observed near the Southern California Offshore Range during periods of mid-frequency active sonar; responses included changes in or cessation of vocalizations, changes in behavior, and leaving the area, and at the highest received levels animals were not present in the area at all (Henderson et al., 2014b). However, these observations were conducted from a vessel off-range, and so any observed responses could not be attributed to the sonar with any certainty. Research on sperm whales in the Caribbean in 1983 coincided with the U.S. intervention in Grenada, where animals were observed scattering and leaving the area in the presence of military sonar, presumably from nearby submarines (Watkins & Schevill, 1975; Watkins et al., 1985). The authors did not report received levels from these exposures and reported similar reactions from noise generated by banging on their boat hull; therefore, it was unclear if the sperm whales were reacting to the sonar signal itself or to a potentially new unknown sound in general.

During aerial and visual monitoring of Navy training events involving sonar, rough-toothed dolphins and unidentified dolphins were observed approaching the vessel with active sonar as if to bowride, while spotted dolphins were observed nearby but did not avoid or approach the vessel (HDR, 2011; U.S. Department of the Navy, 2011d; Watwood et al., 2012). During small boat surveys near the Southern California Offshore Range in southern California, more dolphins were encountered in June compared to a similar survey conducted the previous November after 7 days of mid-frequency sonar activity; it was not investigated if this change was due to the sonar activity or was a seasonal difference that was also observed in other years (Campbell et al., 2010). There were also fewer passive acoustic dolphin detections during and after longer sonar activities in the Marianas Islands Range Complex, with the post-activity absence lasting longer than the mean dolphin absence of 2 days when sonar was not present (Munger et al., 2014; Munger et al., 2015).

Acoustic harassment devices and acoustic deterrent devices have been used to deter marine mammals from fishing gear both to prevent entanglement and to reduce depredation (taking fish). These devices have been used successfully to deter harbor porpoises and beaked whales from getting entangled in fishing nets. For example, Kyhn et al. (2015) tested two types of pingers, one with a 10 kHz tone and one with a broadband 30–160 kHz sweep. Porpoise detection rates were reduced by 65 percent for the sweep and 40 percent for the tone, and while there was some gradual habituation after the first 2–4 exposures, longer term exposures (over 28 days) showed no evidence of additional habituation. Additionally, sperm whales in the Caribbean stopped vocalizing when presented with sounds from nearby acoustic pingers (Watkins & Schevill, 1975). However, acoustic harassment devices used to deter marine mammals from depredating long lines or aquaculture enclosures have proven less successful. For example, Tixier et al. (2014) used a 6.5 kHz pinger with a source level of 195 dB re 1 µPa on a longline to prevent depredation by killer whales, and although two groups of killer whales fled over 700 m away

during the first exposure, they began depredating again after the 3rd and 7th exposures, indicating rapid habituation. In a review of marine mammal deterrents, Schakner & Blumstein (2013) point out that both the characteristics of deterrents and the motivation of the animal play a role in the effectiveness of acoustic harassment devices. Deterrents that are strongly aversive or simulate a predator or are otherwise predictive of a threat are more likely to be effective, unless the animal habituates to the signal or learns that there is no true threat associated with the signal. In some cases net pingers may create a “dinner bell effect”, where marine mammals have learned to associate the signal with the availability of prey (Jefferson & Curry, 1996; Schakner & Blumstein, 2013). This may be why net pingers have been more successful at reducing entanglements for harbor porpoise and beaked whales since these species are not depredating from the nets but are getting entangled when foraging in the area and are unable to detect the net (Carretta et al., 2008; Schakner & Blumstein, 2013). Additional behavioral studies have been conducted with captive harbor porpoises using acoustic alarms, such as those used on fishing nets to help deter marine mammals from becoming caught or entangled (Kastelein et al., 2006; Kastelein et al., 2001). These studies have found that high-frequency sources with varied duration, interval, and sweep characteristics can prove to be effective deterrents for harbor porpoises (Kastelein et al., 2017). van Beest et al. (2017) modeled the long-term, population level impacts of fisheries bycatch, pinger deterrents, and time-area closures on a population of harbor porpoises. They found that when pingers were used alone (in the absence of gillnets or time-area closures), the animals were deterred from the area often enough to cause a population level reduction of 21%, greater even than the modeled level of current bycatch impacts. However, when the pingers were coupled with gillnets in the model, and time-area closures were also used (allowing a net- and pinger-free area for the porpoises to move into while foraging), the population only experienced a 0.8% decline even with current gillnet use levels. This demonstrates that, when used correctly, pingers can successfully deter porpoises from gillnets without leading to any negative impacts.

Controlled experiments have also been conducted on captive animals to estimate received levels at which behavioral responses occur. In one study, bottlenose dolphin behavioral responses were recorded when exposed to 3 kHz sonar-like tones between 115 and 185 dB re 1 μPa (Houser et al., 2013), and in another study bottlenose dolphins and beluga whales were presented with 1-second tones up to 203 dB re 1 μPa to measure TTS (Finneran et al., 2001; Finneran et al., 2003a; Finneran & Schlundt, 2004; Finneran et al., 2005b; Schlundt et al., 2000). During these studies, responses included changes in respiration rate, fluke slaps, and a refusal to participate or return to the location of the sound stimulus. This refusal included what appeared to be deliberate attempts to avoid a sound exposure or to avoid the location of the exposure site during subsequent tests (Finneran et al., 2002; Schlundt et al., 2000). In the behavioral response experiment, bottlenose dolphins demonstrated a 50 percent probability of response at 172 dB re 1 μPa over 10 trials, and in the TTS study bottlenose dolphins exposed to 1-second intense tones exhibited short-term changes in behavior above received sound levels of 178 to 193 dB re 1 μPa, and beluga whales did so at received levels of 180 to 196 dB re 1 μPa and above. In some instances, animals exhibited aggressive behavior toward the test apparatus (Ridgway et al., 1997; Schlundt et al., 2000). While animals were commonly reinforced with food during these studies, the controlled environment and ability to measure received levels provide insight on received levels at which animals will behaviorally responds to noise sources.

Behavioral responses to a variety of sound sources have been studied in harbor porpoises, including acoustic alarms (Kastelein et al., 2006; Kastelein et al., 2001), emissions for underwater data transmission (Kastelein et al., 2005), and tones, including 1–2 kHz and 6–7 kHz sweeps with and without harmonics (Kastelein et al., 2014e), and 25 kHz with and without sidebands (Kastelein et al., 2015e;

Kastelein et al., 2015f). Responses include increased respiration rates, more jumping, or swimming further from the source, but responses were different depending on the source. For example, harbor porpoises responded to the 1–2 kHz upsweep at 123 dB re 1 μPa, but not to the downsweep or the 6–7 kHz tonal at the same level (Kastelein et al., 2014e). When measuring the same sweeps for a startle response, the 50 percent response threshold was 133 and 101 dB re 1 μPa for 1–2 kHz and 6–7 kHz sweeps respectively when no harmonics were present, and decreased to 90 dB re 1 μPa for 1–2 kHz sweeps with harmonics present (Kastelein et al., 2014e). Harbor porpoises responded to seal scarers with broadband signals up to 44 kHz with a slight respiration response at 117 dB re 1 μPa and an avoidance response at 139 dB re 1 μPa, but another scarer with a fundamental (strongest) frequency of 18 kHz didn't have an avoidance response until 151 dB re 1 μPa (Kastelein et al., 2014a). Exposure of the same acoustic pinger to a striped dolphin under the same conditions did not elicit a response (Kastelein et al., 2006), again highlighting the importance in understanding species differences in the tolerance of underwater noise, although sample sizes in these studies was small so these could reflect individual differences as well.

Behavioral responses by odontocetes to sonar and other transducers appear to run the full gamut from no response at all to responses that could potentially lead to long-term consequences for individual animals (e.g., mother-calf separation). This is likely in part due to the fact that this taxonomic group is so broad and includes some of the most sensitive species (e.g., beaked whales and harbor porpoise) as well as some of the least sensitive species (e.g., bottlenose dolphins). This is also the only group for which both field behavioral response studies and captive controlled exposure experiments have been conducted, leading to the assessment of both contextually-driven responses as well as dose-based responses. This wide range in both exposure situations and individual- and species-sensitivities makes reaching general conclusions difficult. However, it does appear as though exposures in close proximity, with multiple vessels that approach the animal lead to higher-level responses in most odontocete species regardless of received level or behavioral state. In contrast, in more "real-world" exposure situations, with distant sources moving in variable directions, behavioral responses appear to be driven by behavioral state, individual experience or species-level sensitivities. These responses may also occur more in-line with received level such that the likelihood of a response would increase with increased received levels. However, these "real-world" responses are more likely to be short-term, lasting the duration of the exposure or even shorter as the animal assesses the sound and (based on prior experience or contextual cues) determines a threat is unlikely. Therefore, while odontocete behavioral responses to Navy sonar will vary across species, populations, and individuals, they are not likely to lead to long-term consequences or population-level effects.

6.4.1.5.2.3 Pinnipeds

Different responses displayed by captive and wild phocid seals to sounds judged to be "unpleasant" or threatening have been reported, including habituation by captive seals (they did not avoid the sound), and avoidance behavior by wild seals (Götz & Janik, 2010). Captive seals received food (reinforcement) during sound playback, while wild seals were exposed opportunistically. These results indicate that motivational state (e.g., reinforcement via food acquisition) can be a factor in whether or not an animal tolerates or habituates to novel or unpleasant sounds. Another study found that captive hooded seals reacted to 1–7 kHz sonar signals, in part with displacement (i.e., avoidance) to the areas of least SPL, at levels between 160 and 170 dB re 1 μPa (Kvadsheim et al., 2010); however, the animals adapted to the sound and did not show the same avoidance behavior upon subsequent exposures. Captive harbor seals responded differently to three signals at 25 kHz with different waveform characteristics and duty cycles.

The seals responded to the frequency modulated signal at received levels over 137 dB re 1 µPa by hauling out more, swimming faster, and raising their heads or jumping out of the water, but did not respond to the continuous wave or combination signals at any received level (up to 156 dB re 1 µPa) (Kastelein et al., 2015d). Captive California sea lions were exposed to mid-frequency sonar at various received levels (125 – 185 dB re 1 µPa) during a repetitive task (Houser et al., 2013). Behavioral responses included a refusal to participate, hauling out, an increase in respiration rate, and an increase in the time spent submerged. Young animals (less than 2 years old) were more likely to respond than older animals. Dose-response curves were developed both including and excluding those young animals. The majority of responses below 155 dB re 1 µPa were changes in respiration, whereas over 170 dB re 1 µPa more severe responses began to occur (such as hauling out or refusing to participate); many of the most severe responses came from the younger animals.

Low-frequency signals of the Acoustic Thermometry of Ocean Climate sound source centered at 75 Hz, with received levels between 118 and 137 dB re 1 µPa, were not found to overtly affect elephant seal dives (Costa et al., 2003). However, they did produce subtle effects that varied in direction and degree among the individual seals, again illustrating the equivocal nature of behavioral effects and consequent difficulty in defining and predicting them.

Harbor seals exposed to seal scarers (i.e., acoustic harassment devices) used to deter seals from fishing nets did not respond at levels of 109–134 dB re 1 µPa and demonstrated minor responses by occasionally hauling out at 128–138 dB re 1 µPa (Kastelein et al., 2015c). Pingers have also been used to deter marine mammals from fishing nets; in some cases, this has led to the “dinner bell effect” where the pinger becomes an attractant rather than a deterrent (Carretta & Barlow, 2011). Steller sea lions were exposed to a variety of tonal, sweep, impulse and broadband sounds. The broadband sounds did not cause a response, nor did the tones at levels below 165 dB re 1 µPa at 1 m, but the 8 kHz tone and 1–4 kHz sweep at source levels of 165 dB re 1 µPa caused the sea lions to haul out (Akamatsu et al., 1996).

Similar to the other taxonomic groups assessed, pinniped behavioral responses to sonar and other active acoustic sources seem to be mediated by the contextual factors of the exposure, including the proximity of the source, the characteristics of the signal, and the behavioral state of the animal. However, all pinniped behavioral response studies have been conducted in captivity, so while these results may be broadly applied to real-world exposure situations, it must be done with caution. Based on exposures to other sound sources in the wild (e.g., impulsive sounds and vessels), pinnipeds are not likely to respond strongly to Navy sonar that is not in close proximity to the animal or approaching the animal.

6.4.1.6 Stranding

Marine mammals are subjected to a variety of natural and anthropogenic factors, acting alone or in combination, which may cause a marine mammal to strand (Geraci et al., 1999; Geraci & Lounsbury, 2005). When a marine mammal (alive or dead) swims or floats onto shore and becomes beached or incapable of returning to sea, the event is termed a “stranding” (Geraci et al., 1999; Geraci & Lounsbury, 2005; Perrin & Geraci, 2002). A stranding can also occur away from the shore if the animal is unable to cope in its present situation (e.g., disabled by a vessel strike, out of habitat) (Geraci & Lounsbury, 2005). Specifically, under U.S. law, a stranding is an event in the wild in which: (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of

the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance" (16 United States Code section 1421h).

Natural factors related to strandings include limited food availability or following prey inshore, predation, disease, parasitism, natural toxins, echolocation disturbance, climatic influences, and aging (Bradshaw et al., 2006; Culik, 2004; Geraci et al., 1999; Geraci & Lounsbury, 2005; Huggins et al., 2015; National Research Council, 2006; Perrin & Geraci, 2002; Walker et al., 2005). Anthropogenic factors include pollution (Hall et al., 2006; Jepson et al., 2005), vessel strike (Geraci & Lounsbury, 2005; Laist et al., 2001), fisheries interactions (Read et al., 2006), entanglement (Baird & Gorgone, 2005; Saez et al., 2012; Saez et al., 2013), human activities (e.g., feeding, gunshot) (Geraci & Lounsbury, 2005; Dierauf & Gulland, 2001), and noise (Cox et al., 2006; National Research Council, 2003; Richardson et al., 1995). For some stranding events, environmental factors (e.g., ocean temperature and wind speed and geographic conditions) can be utilized in predictive models to aid in understanding why marine mammals strand in certain areas more than others (Berini et al., 2015). In most instances, even for the more thoroughly investigated strandings involving post-stranding data collection and necropsies, the cause (or causes) for strandings remains undetermined.

Along the coasts of the continental United States and Alaska between 2001 and 2009, there were on average approximately 12,545 cetacean strandings and 39,104 pinniped strandings (51,649 total) per year (National Marine Fisheries Service, 2016d). Several mass strandings (strandings that involve two or more individuals of the same species, excluding a single mother-calf pair) that have occurred over the past two decades have been associated with anthropogenic activities that introduced sound into the marine environment such as naval operations and seismic surveys. An in-depth discussion of strandings is in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Navy Marine Mammal Program & SPAWAR Systems Center Pacific, 2017).

Sonar use during exercises involving the U.S. Navy has been identified as a contributing cause or factor in five specific mass stranding events: Greece in 1996; the Bahamas in March 2000; Madeira Island, Portugal in 2000; the Canary Islands in 2002, and Spain in 2006 (Cox et al., 2006; Fernandez, 2006; U.S. Navy Marine Mammal Program & SPAWAR Systems Center Pacific, 2017). These five mass strandings have resulted in about 40 known cetacean deaths consisting mostly of beaked whales and with close linkages to mid-frequency active sonar activity. In these circumstances, exposure to non-impulsive acoustic energy was considered a potential indirect cause of death of the marine mammals (Cox et al., 2006). Strandings of other marine mammal species have not been as closely linked to sonar exposure, but rather, have typically been attributed to natural or anthropogenic factors. The Navy has reviewed training requirements, safety procedures, and possible mitigation measures and implemented changes to reduce the potential for acoustic related strandings to occur in the future. Discussions of procedures associated with these and other training and testing events are presented in Chapter 11 (Mitigation Measures), which details all mitigations.

Multiple hypotheses regarding the relationship between non-impulsive sound exposure and stranding have been proposed. These range from direct impact of the sound on the physiology of the marine mammal, to behavioral reactions contributing to altered physiology (e.g., "gas and fat embolic syndrome" (Fernández et al., 2005; Jepson et al., 2003; Jepson et al., 2005), to behaviors directly contributing to the stranding (e.g., beaching of fleeing animals). Unfortunately, without direct

observation of not only the event but also the underlying process, and the potential for artefactual evidence (e.g., chronic condition, previous injury) to complicate conclusions from the post-mortem analyses of stranded animals (Cox et al., 2006), it has not been possible to determine with certainty the exact mechanism underlying these strandings.

Historically, stranding reporting and response efforts have been inconsistent, although they have improved considerably over the last 25 years. Although reporting forms have been standardized nationally, data collection methods, assessment methods, detail of reporting and procedures vary by region and are not yet standardized across the United States. Conditions such as weather, time, location, and decomposition state may also affect the ability to thoroughly examine a specimen (Carretta et al., 2016b; Moore et al., 2013). Because of this, the current ability to interpret long-term trends in marine mammal stranding is limited. While the investigation of stranded animals provides insight into the types of threats marine mammal populations face, investigations are only conducted on a small fraction of the total number of strandings that occur, limiting our understanding of the causes of strandings (Carretta et al., 2016a).

Data were gathered from stranding networks that operate within and adjacent to the HSTT Study Area and reviewed in an attempt to better understand the frequency that marine mammal strandings occur and what major causes of stranding's (both human-related and natural) exist in areas around the HSTT Study Area (National Marine Fisheries Service, 2015a). From 2010 through 2014, there were 314 cetacean and phocid strandings reported in Hawaii, an annual average of 63 strandings per year. Twenty-seven species stranded in this region. The most common species reported include the Hawaiian monk seal, humpback whale, sperm whale, striped and spinner dolphin. Although many marine mammals likely strand due to natural or anthropogenic causes, the majority of reported type of occurrences in marine mammal strandings in the Study Area include fisheries interactions, entanglement, vessel strike and predation. Bradford and Lyman (2015) address overall threats from human activities and industries on stocks in Hawaii.

In 2004, a mass stranding event of melon-headed whales occurred in Hanalei Bay. It is speculated that sonar operated during a major training exercise may be related to the incident. Upon further investigation, sonar was only considered as a plausible, but not sole, contributing factor among many factors in the event. The Hanalei Bay incident does not share the characteristics observed with other mass strandings of whales coincident with sonar activity (e.g., specific traumas, species composition, etc.) (Southall et al., 2006; U.S. Navy Marine Mammal Program & SPAWAR Systems Center Pacific, 2017). Additional information on this event is available in the Navy's Technical Report on Marine Mammal Strandings Associated with U.S. Navy Sonar Activities (U.S. Navy Marine Mammal Program & SPAWAR Systems Center Pacific, 2017).

Records for strandings in San Diego County (covering the shoreline for the Southern California portion of the HSTT Study Area) indicate that there were 143 cetacean and 1,235 pinniped strandings between 2010 and 2014, an annual average of about 29 and 247 per year, respectively. A total of 16 different species have been reported as stranded within this time frame. The majority of species reported include long-beaked common dolphins and California sea lions, but there were also reports of pacific white-sided, bottlenose and Risso's dolphins, gray, humpback, and fin whales, harbor seals and Northern elephant seals (National Marine Fisheries Service, 2015c, 2016c). However, stranded marine mammals are reported along the entire western coast of the United States each year. Within the same timeframe, there were 714 cetacean and 11,132 pinniped strandings reported outside of the Study Area, an annual

average of about 142 and 2,226 respectively. Species that strand along the entire west coast are similar to those that typically strand within the Study Area with additional reports of harbor porpoise, Dall's porpoise, Steller sea lions, and various fur seals. The most common reported type of occurrence in stranded marine mammals in this region include fishery interactions, illness, predation, and vessel strikes (National Marine Fisheries Service, 2016c). It is important to note that the mass stranding of pinnipeds along the west coast considered part of a NMFS declared Unusual Morality Event are still being evaluated. The likely cause of this event is the lack of available prey near rookeries due to warming ocean temperatures (National Oceanic and Atmospheric Administration, 2016). Carretta et al. (2013b; 2016b) provide additional information and data on the threats from human-related activities and the potential causes of strandings for the U.S. Pacific coast marine mammal stocks.

6.4.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate (see Section 6.2). Physical effects that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment or chronic masking, which could impact navigation, foraging, predator avoidance, or communication. The long-term consequences due to individual behavioral reactions and short-term or chronic instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies, especially for long-lived animals like marine mammals. For example, a lost reproductive opportunity could be a measureable cost to the individual, or for very small populations to the population as a whole (e.g., Hawaiian monk seals; however, short-term costs may be recouped during the life of an otherwise healthy individual. These factors are taken into consideration when assessing risk of long-term consequences. It is more likely that any long-term consequences to an individual would be a result of costs accumulated over a season, year, or life stage due to multiple behavioral or stress responses resulting from exposure to many sound-producing activities over significant periods.

Marine mammals exposed to high levels of human activities may leave the area, habituate to the activity, or tolerate the disturbance and remain in the area (Wartzok et al., 2003). Longer-term displacement can lead to changes in abundance or distribution patterns of the species in the affected region (Bejder et al., 2006b; Blackwell et al., 2004; Teilmann et al., 2006). Gray whales in Baja California abandoned a historical breeding lagoon in the mid-1960s due to an increase in dredging and commercial shipping operations. However, whales did repopulate the lagoon after shipping activities had ceased for several years (Bryant et al., 1984). Mysticetes in the northeast tended to adjust to vessel traffic over a number a of years, trending towards more neutral responses to passing vessels (Watkins, 1986), indicating that some animals may habituate or otherwise learn to cope with high levels of human activity. Bejder et al. (2006a) studied responses of bottlenose dolphins to vessel approaches and found that lesser reactions in populations of dolphins regularly subjected to high levels of vessel traffic could be a sign of habituation, or it could be that the more sensitive animals in this population previously abandoned the area of higher human activity.

Moore and Barlow (2013) noted a decline in the overall beaked whale population in a broad area of the Pacific Ocean along the U.S. west coast. Moore and Barlow (2013) provide several hypotheses for the decline of beaked whales in those waters, one of which is anthropogenic sound including the use of sonar by the U.S. Navy; however, new data has been published raising uncertainties over whether a decline in the beaked whale population occurred off the U.S. west coast between 1996 and 2014 (Barlow, 2016). In addition, studies on the Atlantic Undersea Test and Evaluation Center instrumented

range in the Bahamas have shown that some Blainville's beaked whales may be resident during all or part of the year in the area. Individuals may move off the range for several days during and following a sonar event, but return within a few days (McCarthy et al., 2011; Tyack et al., 2011). Photo identification studies in the Southern California Range Complex have identified approximately 100 individual Cuvier's beaked whale individuals, with 40 percent having been seen in one or more prior years and re-sightings up to 7 years apart (Falcone et al., 2009; Falcone & Schorr, 2014). These results indicate long-term residency by individuals in an intensively used Navy training and testing area, which may suggest a lack of long-term consequences as a result of exposure to Navy training and testing activities, but could also be indicative of high-value resources that exceed the cost of remaining in the area. Long-term residency does not mean there has been no impact to population growth rates and there are no data existing on the reproductive rates of populations inhabiting the Navy range area around San Clemente Island as opposed to beaked whales from other areas. In that regard however, recent results from photo-identifications are beginning to provide critically needed calving and weaning rate data for resident animals on the Navy's Southern California range. Three adult females that had been sighted with calves in previous years were again sighted in 2016, one of these was associated with her second calf, and a fourth female that was first identified in 2015 without a calf, was sighted in 2016 with a calf (Schorr et al., 2017). Resident females documented with and without calves from year to year will provide the data for this population that can be applied to future research questions.

Research involving three tagged Cuvier's beaked whales in the Southern California Range Complex reported on by Falcone and Schorr (2012, 2014) has documented movements in excess of hundreds of kilometers by some of those animals. Schorr et al. (2014) reported the results for an additional eight tagged Cuvier's beaked whales in the same area. Five of these eight whales made journeys of approximately 250 km from their tag deployment location, and one of these five made an extra-regional excursion over 450 km south to Mexico and back again. Given that some beaked whales may routinely move hundreds of kilometers as part of their normal pattern (Schorr et al., 2014), temporarily leaving an area to avoid sonar or other anthropogenic activity may have little cost.

Another approach has been an attempt to link short-term effects to individuals due to anthropogenic stressors with long-term consequences to populations using population models. Population models are well known from many fields in biology including fisheries and wildlife management. These models accept inputs for the population size and changes in vital rates of the population such as the mean values for survival age, lifetime reproductive success, and recruitment of new individuals into the population. Unfortunately, for acoustic and explosive impacts on marine mammal populations, many of the inputs required by population models are not known. Nowacek et al. (2016) reviewed new technologies, including passive acoustic monitoring, tagging, and the use of unmanned aerial vehicles, that can improve scientists' abilities to study these model inputs and link behavioral changes to individual life functions and ultimately population-level effects. The linkage between immediate behavioral or physiological effects to an individual due to a stressor such as sound, the subsequent effects on that individual's vital rates (growth, survival, and reproduction), and in turn the consequences for the population have been reviewed in National Research Council (2005).

The Population Consequences of Acoustic Disturbance model (National Research Council 2005) proposes a conceptual model for determining how changes in the vital rates of individuals (i.e., a biologically significant consequence to the individual) translates into biologically significant consequences to the population. In 2009, the U.S. Office of Naval Research set up a working group to transform the Population Consequences of Acoustic Disturbance framework into a mathematical model and include

other stressors potentially causing disturbance in addition to noise. The model, now called Population Consequences of Disturbance, has been used for case studies involving bottlenose dolphins, North Atlantic right whales, beaked whales, southern elephant seals, California sea lions, blue whales, humpback whales, and harbor porpoise (Harwood & King, 2014; Hatch et al., 2012; King et al., 2015; New et al., 2013a; New et al., 2013b; New et al., 2014), but the Population Consequences of Disturbance model is still in the preliminary stages of development.

Costa et al. (2016a) emphasized taking into account the size of an animal's home range, whether populations are resident and non-migratory or if they migrate over long areas and share their feeding or breeding areas with other populations. These factors, coupled with the extent, location, and duration of a disturbance can lead to markedly different impact results. For example, Costa (2016a) modeled seismic surveys with different radii of impacts on the foraging grounds of Bering Sea humpback whales, West Antarctic Peninsula humpback whales, and California Current blue whales, and used data from tagged whales to determine foraging locations and effort on those grounds. They found that for the blue whales and the West Antarctic humpback whales, less than 19 percent and 16 percent(respectively) of each population would be exposed, and less than 19 percent and 6percent of foraging behavior would be disturbed. This was likely due to the fact that these populations forage for krill over large areas. In contrast, the Bering Sea population of humpback whales had over 90 percent of the population exposed when the disturbance zones extended beyond 50 km, and 100 percent of their foraging behavior was disturbed when the zone was over 25 km. These animals forage for fish over a much smaller area, thereby having a limited range for foraging that can be disturbed. Similary, Costa et al. (2016b) placed disturbance zones in the foraging and transit areas of northern elephant seals and California sea lions. Again, the location and radius of disturbance impacted how many animals were exposed and for how long, with California sea lions disturbed for a longer period than elephant seals, which extend over a broader foraging and transit area. However, even the animals exposed for the longest periods had negligible modeled impacts to their reproduction and pup survival rates.

Using the Population Consequences of Disturbance framework, modeling of the long-term consequences of exposure has been conducted for a variety of marine mammal species and stressors. Even when high and frequent exposure levels are included, few long-term consequences have been predicted. For example, De Silva et al. (2014) conducted a population viability analysis on the long-term impacts of pile driving and construction noise on harbor porpoises and bottlenose dolphins. Despite including the extreme and unlikely assumptions that 25 percent of animals that received PTS would die, and that behavioral displacement from an area would lead to breeding failure, the model only found short-term impacts to the population size and no long-term effects on population viability. Similarly, King et al. (2015) developed a Population Consequences of Disturbance framework using expert elicitation data on impacts from wind farms on harbor porpoises, and even under the worst case scenarios predicted less than a 0.5 percent decline in harbor porpoise populations. Nabe-Nelson et al. (2014) also modeled the impact of noise from wind farms on harbor porpoises and predicted that even when assuming a 10 percent reduction in population size if prey is impacted up to two days, the presence of ships and wind turbines did not deplete the population. In contrast, Heinis and De Jong (2015) used the Population Consequences of Disturbance framework to estimate impacts from both pile driving and seismic exploration on harbor porpoises and found a 23 percent in population size over six years, with an increased risk for further reduction with additional disturbance days.

The Population Consequences of Disturbance model developed by New et al. (2013b) predicted that beaked whales require energy dense prey and high quality habitat, and that non-lethal disturbances that

displace whales from that habitat could lead to long-term impacts on fecundity and survival; however, the authors were forced to use many conservative assumptions within their model since many parameters are unknown for beaked whales. As discussed above in Schorr et al. (2014), beaked whales have been tracked roaming over distances of 250 km or more indicating that temporary displacement from a small area may not preclude finding energy dense prey or high quality habitat. Another Population Consequences of Disturbance model developed in New et al. (2014) predicted elephant seal populations to be relatively robust even with a greater than 50 percent reduction in foraging trips (only a 0.4 percent population decline in the following year). It should be noted that in all of these models, assumptions were made and many input variables were unknown and so were estimated using available data. It is still not possible to utilize individual short-term behavioral responses to estimate long-term or population level effects.

The best assessment of long-term consequences from Navy training and testing activities will be to monitor the populations over time within the Study Area. A U.S. workshop on Marine Mammals and Sound (Fitch et al., 2011) indicated a critical need for baseline biological data on marine mammal abundance, distribution, habitat, and behavior over sufficient time and space to evaluate impacts from human-generated activities on long-term population survival. The Navy has developed and implemented comprehensive monitoring plans since 2009 for protected marine mammals occurring on Navy ranges with the goal of assessing the impacts of training and testing activities on marine species and the effectiveness of the Navy's current mitigation practices. The results of this long-term monitoring are now being compiled and analyzed for trends in occurrence or abundance over time (Martin et al., 2017); preliminary results of this analysis at PMRF indicate no changes in detection rates for several species over the past decade. Continued monitoring efforts over time will be necessary to begin to evaluate the long-term consequences of exposure to noise sources.

6.4.2 Impacts from Sonar and Other Transducers

Sonar and other transducers proposed for use could be used throughout the Study Area. Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. General categories of these systems are described in Section 1.4.1 (Acoustic Stressors).

Sonar induced acoustic resonance and bubble formation phenomena are very unlikely to occur under realistic conditions, as discussed in Section 6.4.1.1 (Injury). Non-auditory injury (i.e., other than PTS) and mortality from sonar and other transducers is so unlikely as to be discountable under normal conditions and is therefore not considered further in this analysis.

The most probable impacts from exposure to sonar and other transducers are PTS, TTS, behavioral reactions, masking, and physiological stress (Sections 6.4.1.2, Hearing Loss and Auditory Injury; 6.4.1.3, Physiological Stress; and 6.4.1.5, Behavioral Reactions).

6.4.2.1.1 Methods for Analyzing Impacts from Sonars and Other Transducers

The Navy performed a quantitative analysis to estimate the number of times that marine mammals could be affected by sonars and other transducers used during Navy training and testing activities. The Navy Acoustic Effects Model is used to produce initial estimates of the number of animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. A detailed explanation of this analysis is provided in the technical report titled *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

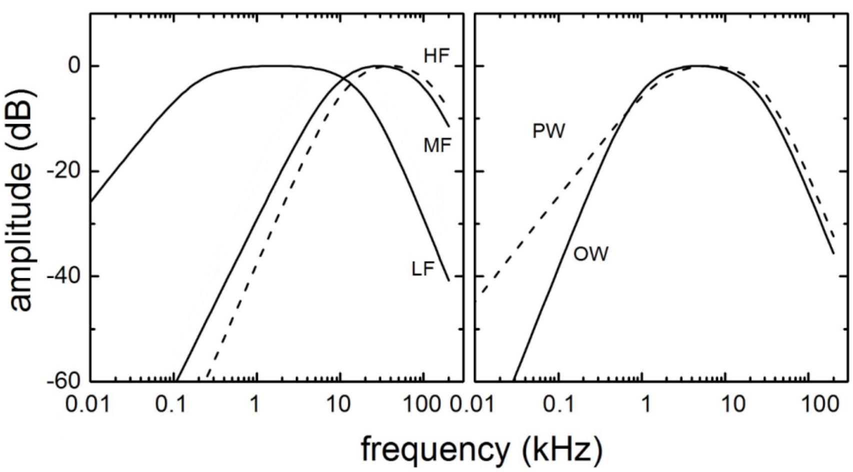
6.4.2.1.1.1 Criteria and Thresholds Used to Estimate Impacts from Sonar and Other Transducers

See the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived.

Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used (For parameters used to generate the functions and more information on weighting function derivation see U.S. Department of the Navy (2017)

Figure 6-5). Auditory weighting functions are mathematical functions that adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges with less or no auditory sensitivity. They are based on a generic band pass filter and incorporates species-specific hearing abilities to calculate a weighted received sound level in units SPL or SEL. Due to the band pass nature of auditory weighting functions, they resemble an inverted "U" shape with amplitude plotted as a function of frequency. The flatter portion of the plotted function, where the amplitude is closest to zero, is the emphasized frequency range (i.e., the pass-band), while the frequencies below and above this range (where amplitude declines) are de-emphasized.

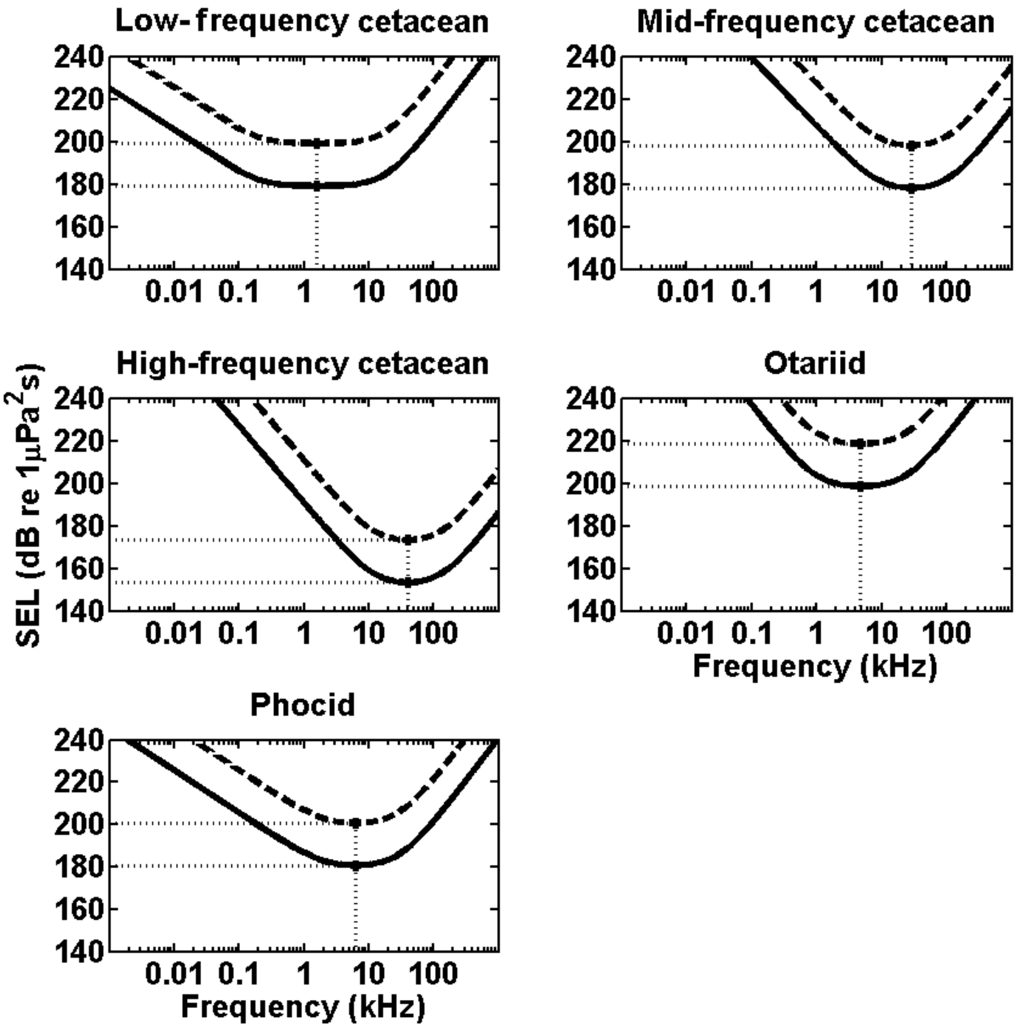


For parameters used to generate the functions and more information on weighting function derivation see U.S. Department of the Navy (2017)

Figure 6-5: Navy Weighting Functions For All Species Groups

Hearing Loss from Sonar and Other Transducers

Defining the TTS and PTS exposure functions (see Figure 6-6) requires identifying the weighted exposures necessary for TTS and PTS onset from sounds produced by sonar and other transducers. The criteria used to define threshold shifts from non-impulsive sources (e.g., sonar) determines TTS onset as the SEL necessary to induce 6 dB of threshold shift. A sound exposure level 20 dB above the onset of TTS is used in all hearing groups of marine mammals underwater to define the PTS threshold (Southall et al., 2007).



The solid curve is the exposure function for TTS onset and the large dashed curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL threshold for TTS and PTS onset in the frequency range of best hearing.

Figure 6-6: TTS and PTS Exposure Functions for Sonar and Other Transducers

Behavioral Responses from Sonar and Other Transducers

Behavioral response criteria are used to estimate the number of animals that may exhibit a behavioral response to sonar and other transducers. See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017c) for detailed information on how the Behavioral Response Functions were derived. Developing the new behavioral criteria involved multiple steps. All peer-reviewed published behavioral response studies conducted both in the field and on captive animals were examined in order to understand the breadth of behavioral responses of marine mammals to sonar and other transducers.

The data from the behavioral studies were analyzed by looking for significant responses, or lack thereof, for each experimental session. The terms "significant response" or "significant behavioral response" are used in describing behavioral observations from field or captive animal research that may rise to the level of "harassment" for military readiness activities. Under the MMPA, for military readiness activities, such as Navy training and testing, behavioral "harassment" is: "any act that *disturbs* or is likely to *disturb* a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering*, to a point where such behavioral patterns are abandoned or significantly altered*." (Section 315(f) of Public Law 107-314; 16 United States Code 703 note).

Due to the nature of behavioral response research to date, it is not currently possible to ascertain the types of observed reactions that would lead to an abandonment or significant alteration of a natural behavior pattern. Therefore, the Navy has developed a methodology to estimate the possible significance of behavioral reactions and impacts on natural behavior patterns.

Behavioral response severity is described herein as 'low', 'moderate', or 'high'. These are derived from the Southall et al. (2007) severity scale. Low severity responses are those behavioral responses that fall within an animal's range of typical (baseline) behaviors and are unlikely to disrupt an individual to a point where natural behavior patterns are significantly altered or abandoned. Low severity responses include an orientation or startle response, change in respiration, change in heart rate, and change in group spacing or synchrony.

Moderate severity responses could become significant if sustained over a longer duration. What constitutes a long-duration response is different for each situation and species, although it is likely dependent upon the magnitude of the response and species characteristics such as age, body size, feeding strategy, and behavioral state at the time of the exposure. In general, a response could be considered "long-duration" if it lasted for a few tens of minutes to a few hours, or enough time to significantly disrupt an animal's daily routine.

Moderate severity responses included:

- alter migration path
- alter locomotion (speed, heading)
- alter dive profiles
- stop/alter nursing
- stop/alter breeding
- stop/alter feeding/foraging
- stop/alter sheltering/resting
- stop/alter vocal behavior if tied to foraging or social cohesion
- avoidance of area near sound source

For the derivation of behavioral criteria, a significant duration was defined as a response that lasted for the duration of exposure or longer, regardless of how long the exposure session may have been. This assumption was made because it was not possible to tell if the behavioral responses would have continued if the exposure had continued. The costs associated with these observed behavioral reactions were not measured so it is not possible to judge whether reactions would have risen to the level of significance as defined above, although it was conservatively assumed to be the case. High severity

responses include those responses with immediate consequences (e.g., stranding, mother-calf separation), and were always considered significant behavioral reactions regardless of duration.

Marine mammal species were placed into behavioral criteria groups based on their known or suspected behavioral sensitivities to sound (Figure 6-7 through Figure 6-10). In most cases, these divisions are driven by taxonomic classifications (e.g., mysticetes, pinnipeds).

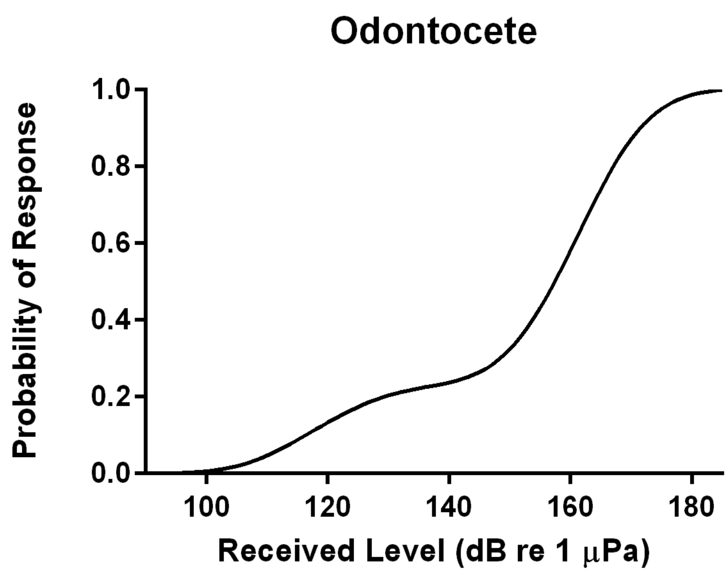


Figure 6-7: Behavioral Response Function for Odontocetes

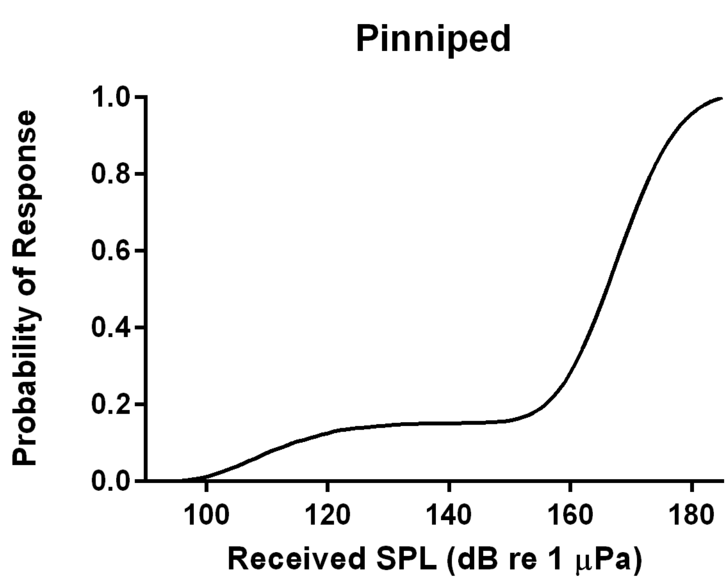


Figure 6-8: Behavioral Response Function for Pinnipeds.

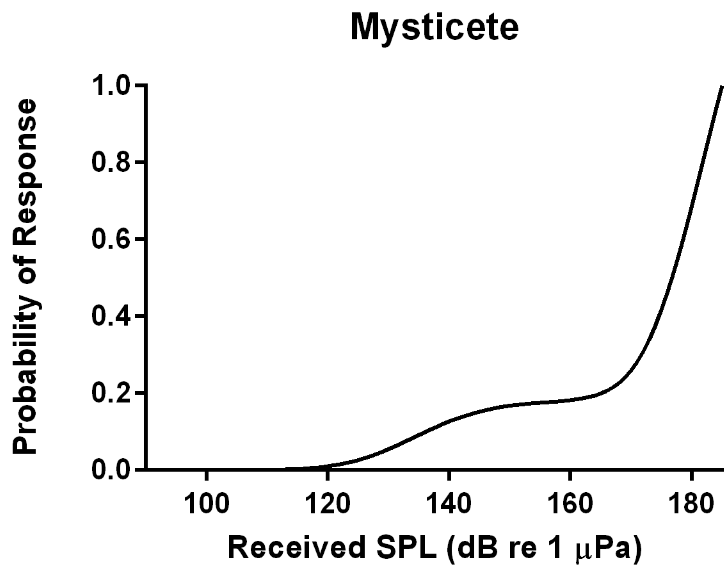


Figure 6-9: Behavioral Response Function for Mysticetes

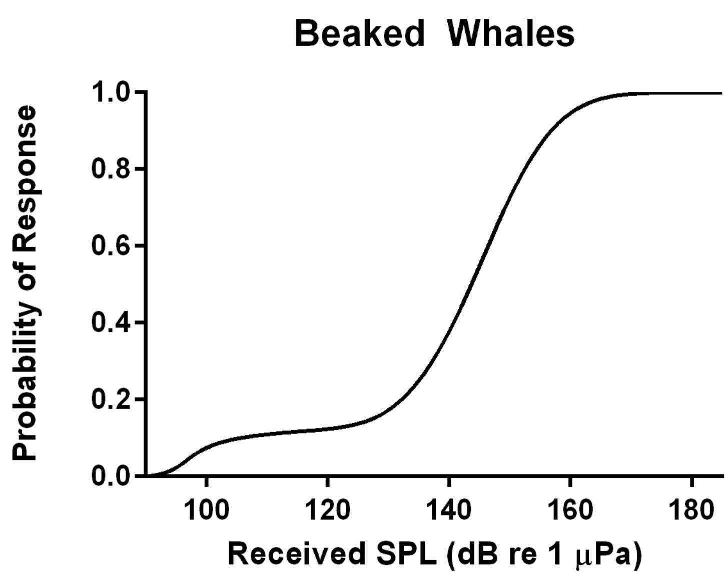


Figure 6-10: Behavioral Response Function for Beaked Whales

For all taxa, distances beyond which significant behavioral responses to sonar and other active acoustic sources are unlikely to occur, denoted as “cutoff distances,” were defined based on existing data (Table 6-2). The distance between the animal and the sound source is a strong factor in determining that animal’s potential reaction (e.g., DeRuiter et al., 2013b). For training and testing exercises that contain

multiple platforms or tactical sonar sources that exceed 215 dB re 1 µPa @ 1 m, this cutoff distance is substantially increased (i.e., doubled) from values derived from the literature. The use of multiple platforms and intense sound sources are factors that probably increase responsiveness in marine mammals overall. There are currently few behavioral observations under these circumstances; therefore, the Navy will conservatively predict significant behavioral responses at further ranges for these more intense activities.

Table 6-2: Cutoff Distances for Moderate Source Level, Single Platform Training and Testing Events and for All Other Events with Multiple Platforms or Sonar with Source Levels at or Exceeding 215 dB re 1 µPa @ 1 m

Criteria Group	*Moderate SL/Single Platform Cutoff Distance*	*High SL/Multi-Platform Cutoff Distance*
Odontocetes	10 km	20 km
Pinnipeds	5 km	10 km
Mysticetes	10 km	20 km
Beaked Whales	25 km	50 km

6.4.2.1.2 Assessing the Severity of Behavioral Responses from Sonar

As discussed above, the terms “significant response” or “significant behavioral response” are used in describing behavioral reactions that may lead to an abandonment or significant alteration of a natural behavior pattern. Due to the limited amount of behavioral response research to date and relatively short durations of observation, it is not possible to ascertain the true significance of the majority of the observed reactions. When deriving the behavioral criteria, it was assumed that most reactions that lasted for the duration of the sound exposure or longer were significant, even though many of the exposures lasted for 30 minutes or less. Furthermore, the experimental designs used during many of the behavioral response studies were unlike Navy activities in many important ways. These differences include tagging subject animals, following subjects for sometimes hours before the exposure, vectoring towards the subjects after animals began to avoid the sound source, and multiple close passes on focal groups. This makes the estimated behavioral impacts from Navy activities using the criteria derived from these experiments difficult to interpret. It is not currently possible to distinguish between significant and insignificant behavioral reactions using the functions derived using this data, although it is assumed for the purposes of this analysis that more intense and longer duration activities would lead to a higher probability of animals having significant behavioral reactions.

The estimated behavioral reactions from the Navy’s quantitative analysis are grouped into several categories based on the most powerful sonar source, the number of platforms, the duration, and geographic extent of each Navy activity attributed to the predicted impact. Activities that occur on Navy instrumented ranges or within Navy homeports require special consideration due to the repeated nature of activities in these areas.

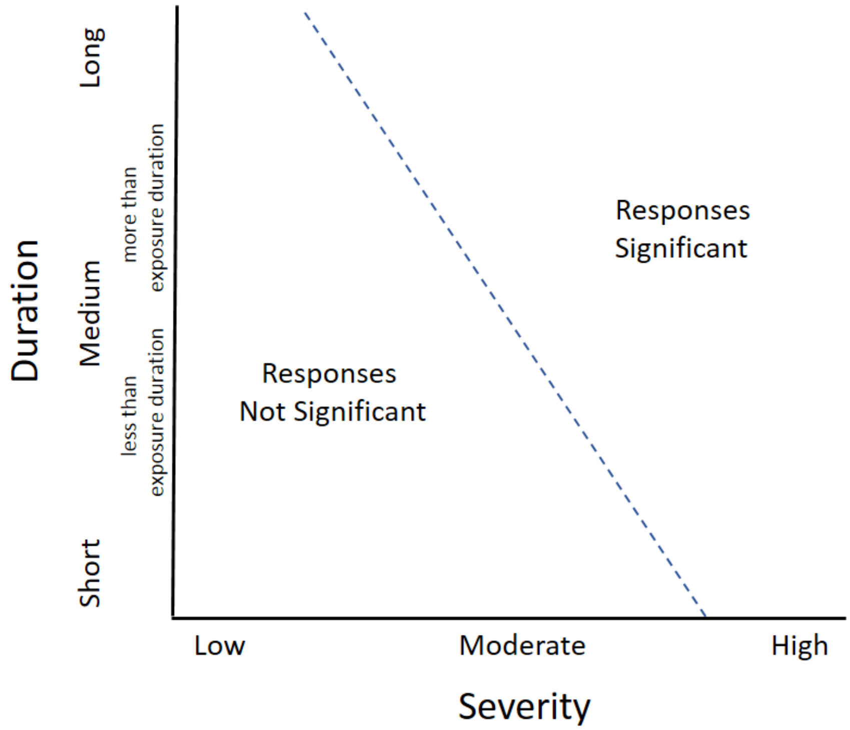


Figure 6-11: Relative Likelihood of a Response Being Significant Based on the Duration and Severity of Behavioral Reactions

Low severity responses are within an animal's range of typical (baseline) behaviors and are unlikely to disrupt an individual to a point where natural behavior patterns are significantly altered or abandoned. Although the derivation of the Navy's behavioral criteria did not count low severity responses as significant behavioral responses, in practice, some reactions estimated using the behavioral criteria are likely to be low severity (Figure 6-11).

High severity responses are those with a higher potential for direct consequences to growth, survivability, or reproduction. Examples include prolonged separation of females and dependent offspring, panic, flight, stampede, or stranding. High severity reactions would always be considered significant, however these types of reactions are probably rare under most conditions and may still not lead to direct consequences on survivability. For example, a separation of a killer whale mother-calf pair was observed once during a behavioral response study to an active sonar source (Miller et al., 2014), but the animals were rejoined as soon as the ship had passed. Therefore, although this was a severe response, it did not lead to a negative outcome. Five beaked whale strandings have also occurred associated with U.S. Navy active sonar use as discussed above (see Section 6.5.1.6, Stranding), but the confluence of factors that contributed to those strandings is now better understood, and the avoidance of those factors has resulted in no known marine mammal strandings associated with U.S. Navy sonar activities for over a decade.

The Navy is unable to predict these high severity responses for any activities since the probability of occurrence is apparently very low, although the Navy acknowledges that severe reactions could occasionally occur. In fact, no significant behavioral responses such as panic, stranding or other severe reactions have been observed during monitoring of actual training or testing activities.

Many of the responses estimated using the Navy's quantitative analysis are most likely to be moderate severity. Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion. As mentioned previously, the behavioral response functions used within the Navy's quantitative analysis were primarily derived from experiments using short-duration sound exposures lasting, in many cases, for less than 30 minutes. If animals exhibited moderate severity reactions for the duration of the exposure or longer, then it was conservatively assumed that the animal experienced a significant behavioral reaction. However the experiments did not include measurements of costs to animals beyond the immediately observed reactions, and no direct correlations exist between an observed behavioral response and a cost that may result in long-term consequences. Within the Navy's quantitative analysis, many behavioral reactions are estimated from exposure to sonar that may exceed an animal's behavioral threshold for only a single ping to several minutes. It is likely that many of the estimated behavioral reactions within the Navy's quantitative analysis would not constitute significant behavioral reactions; however, the numbers of significant verses non-significant behavioral reactions are currently impossible to predict.

6.4.2.1.3 Marine Mammal Density

A quantitative analysis of impacts on a species requires data on their abundance and distribution in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. To characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. The Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal species present within the Study Area. This database is described in the technical report titled *U.S. Navy Marine Species Density Database Phase III for the Hawaii-Southern California Training and Testing Study Area* (U.S. Department of the Navy, 2017e), hereafter referred to as the Density Technical Report.

A variety of density data and density models are needed in order to develop a density database that encompasses the entirety of the Study Area. Because this data is collected using different methods with varying amounts of accuracy and uncertainty, the Navy has developed a model hierarchy to ensure the most accurate data is used when available. The density technical report describes these models in detail and provides detailed explanations of the models applied to each species density estimate. The below list describes models in order of preference.

1. Spatial density models are preferred and used when available because they provide an estimate with the least amount of uncertainty by deriving estimates for divided segments of the sampling area. These models (see Becker et al., 2016; Forney et al., 2015) predict spatial variability of animal presence as a function of habitat variables (e.g., sea surface temperature, seafloor depth, etc.). This model is developed for areas, species, and, when available, specific timeframes (months or seasons) with sufficient survey data.
2. Stratified designed-based density estimates use line-transect survey data with the sampling area divided (stratified) into sub-regions, and a density is predicted for each sub-region (see Barlow, 2016; Becker et al., 2016; Bradford et al., 2017; Campbell et al., 2014; Jefferson et al., 2014). While geographically stratified density estimates provide a better indication of a species'

distribution within the study area, the uncertainty is typically high because each sub-region estimate is based on a smaller stratified segment of the overall survey effort.

3. Design-based density estimations use line-transect survey data from land and aerial surveys designed to cover a specific geographic area (see Carretta et al., 2015). These estimates use the same survey data as Stratified design-based estimates, but are not segmented into sub-regions and instead provide one estimate for a large surveyed area.

Although relative environmental suitability (RES) models provide estimates for areas of the oceans that have not been surveyed using information on species occurrence and inferred habitat associations and have been used in past density databases, these models were not used in the current quantitative analysis.

When interpreting the results of the quantitative analysis, as described in the density technical report it is important to consider that "each model is limited to the variables and assumptions considered by the original data source provider. No mathematical model representation of any biological population is perfect, and with regards to marine mammal biodiversity, any single model will not completely explain the results." (U.S. Department of the Navy, 2017a)

These factors and others described in the density technical report should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

6.4.2.1.4 The Navy's Acoustic Effects Model

The Navy's Acoustic Effects Model calculates sound energy propagation from sonar and other transducers during naval activities and the sound received by animat dosimeters. Animat dosimeters are virtual representations of marine mammals distributed in the area around the modeled naval activity that each records its individual sound "dose." The model bases the distribution of animats over the Study Area on the density values in the Navy Marine Species Density Database and distributes animats in the water column proportional to the known time that species spend at varying depths.

The model accounts for environmental variability of sound propagation in both distance and depth when computing the received sound level on the animats. The model conducts a statistical analysis based on multiple model runs to compute the estimated effects on animals. The number of animats that exceed the thresholds for effects is tallied to provide an estimate of the number of marine mammals that could be affected.

Assumptions in the Navy model intentionally err on the side of overestimation when there are unknowns. Naval activities are modeled as though they would occur regardless of proximity to marine mammals (i.e., mitigation is not modeled) and without any avoidance of the activity by the animal. The final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation and the possibility that marine mammals would avoid continued or repeated sound exposures.

The model estimates the impacts caused by individual training and testing exercises. During any individual modeled event, impacts to individual animats are considered over 24-hour periods. The

animats do not represent actual animals, but rather allow for a statistical analysis of the number of instances that marine mammals may be exposed to sound levels resulting in an effect. Therefore, the model estimates the number of instances in which an effect threshold was exceeded over the course of a year, but does not estimate the number of individual marine mammals that may be impacted over a year (i.e., some marine mammals could be impacted several times, while others would not experience any impact). A detailed explanation of the Navy's Acoustic Effects Model is provided in the technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

6.4.2.1.4.1 Accounting for Mitigation

The Navy implements mitigation measures (described in Chapter 11, Mitigation Measures) during activities that use sonar and other transducers, including the power-down or shut-down (i.e., power-off) of sonar when a marine mammal is observed in the mitigation zone. The mitigation zones encompass the estimated ranges to injury (including PTS) for a given sonar exposure. Therefore, the impact analysis quantifies the potential for mitigation to reduce the risk of PTS. Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, some model-estimated PTS is considered mitigated to the level of TTS. The impact analysis does not analyze the potential for mitigation to reduce TTS or behavioral effects, even though mitigation could also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

The ability to observe the range to PTS was estimated for each training or testing event. The ability of Navy Lookouts to detect marine mammals in or approaching the mitigation zone is dependent on the animal's presence at the surface and the characteristics of the animal that influence its sightability (such as group size or surface active behavior). The behaviors and characteristics of some species may make them easier to detect. For example, based on small boat surveys between 2000 and 2012 in the Hawaiian Islands, pantropical spotted dolphins and striped dolphins were frequently observed leaping out of the water and Cuvier's beaked whales (Baird et al., 2013d) and Blainville's beaked whales (HDR, 2012) were occasionally observed breaching. These behaviors are visible from a great distance and likely increase sighting distances and detections of these species. Environmental conditions under which the training or testing activity could take place are also considered such as the sea surface conditions, weather (e.g., fog or rain), and day versus night.

6.4.2.1.4.2 Marine Mammal Avoidance of Sonar and other Transducers

Because a marine mammal is assumed to initiate avoidance behavior after an initial startle reaction when exposed to relatively high-received levels of sound, a marine mammal could reduce its cumulative

sound energy exposure over a sonar event with multiple pings (i.e., sound exposures). This would reduce risk of both PTS and TTS, although the quantitative analysis conservatively only considers the potential to reduce instances of PTS by accounting for marine mammals swimming away to avoid repeated high-level sound exposures. All reductions in PTS impacts from likely avoidance behaviors are instead considered TTS impacts.

6.4.2.2 Impact Ranges for Sonar and Other Transducers

The following section provides range to effects for sonar and other active acoustic sources to specific criteria determined using the Navy Acoustic Effects Model. Marine mammals within these ranges would be predicted to receive the associated effect. Range to effects is important information in not only predicting acoustic impacts, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals.

The ranges to the PTS threshold for exposures of 30 seconds are shown in Table 6-3 relative to the marine mammal's functional hearing group. This period (30 seconds) was chosen based on examining the maximum amount of time a marine mammal would realistically be exposed to levels that could cause the onset of PTS based on platform (e.g., ship) speed and a nominal animal swim speed of approximately 1.5 meters per second. The ranges provided in the table include the average range to PTS, as well as the range from the minimum to the maximum distance at which PTS is possible for each hearing group. For a SQS-53C (i.e., bin MF1) sonar transmitting for 30 seconds at 3 kHz and a source level of 235 dB re 1 μPa^2-s at 1 m, the average range to PTS for the most sensitive species (the high-frequency cetaceans) extends from the source to a range of 181 m. PTS ranges for all other functional hearing groups, besides high-frequency cetaceans, are much shorter. Since any hull-mounted sonar, such as the SQS-53, engaged in anti-submarine warfare training would be moving at between 10–15 knots and nominally pinging every 50 seconds, the vessel will have traveled a minimum distance of approximately 257 m during the time between those pings (note: 10 knots is the speed used in the Navy Acoustic Effects Model). As a result, there is little overlap of PTS footprints from successive pings, indicating that in most cases, an animal predicted to receive PTS would do so from a single exposure (i.e., ping). For all other bins (besides MF1), PTS ranges are short enough that marine mammals (with a nominal swim speed of approximately 1.5 meters per second) should be able to avoid higher sound levels capable of causing onset PTS within this 30-second period.

For all other functional hearing groups (low-frequency cetaceans, mid-frequency cetaceans, phocid, seals, and otariids), 30-second average PTS zones are substantially shorter. A scenario could occur where an animal does not leave the vicinity of a ship or travels a course parallel to the ship, however, the close distances required make PTS exposure unlikely. For a Navy vessel moving at a nominal 10 knots, it is unlikely a marine mammal could maintain the speed to parallel the ship and receive adequate energy over successive pings to suffer PTS.

The tables below illustrate the range to TTS for one, 30, 60 and 120 seconds from five representative sonar systems (see Table 6 4 through Table 6 8). Due to the lower acoustic thresholds for TTS versus PTS, ranges to TTS are longer. Therefore, successive pings can be expected to add together, further increasing the range to onset-TTS.

Table 6-3: Range to Permanent Threshold Shift for Five Representative Sonar Systems

Functional Hearing Group	Approximate Range in Meters for PTS from 30 sec Exposure				
	Sonar Bin LF	Sonar Bin MF1	Sonar Bin MF4	Sonar Bin MF5	Sonar Bin HF4
Low-frequency Cetacean	0 (0–0)	65 (65–65)	14 (0–15)	0 (0–0)	0 (0–0)
Mid-frequency Cetacean	0 (0–0)	16 (16–16)	3 (3–3)	0 (0–0)	1 (0–2)
High-frequency Cetacean	0 (0–0)	181 (180–190)	30 (30–30)	9 (8–10)	30 (8–80)
Otariidae	0 (0–0)	6 (6–6)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	0 (0–0)	45 (45–45)	11 (11–11)	0 (0–0)	0 (0–0)

[1] PTS ranges extend from the sonar or other active acoustic sound source to the indicated distance. The average range to PTS is provided as well as the range from the estimated minimum to the maximum range to PTS in parenthesis.

Table 6-4: Ranges to Temporary Threshold Shift for Sonar Bin LF5 over a Representative Range of Environments Within the Study Area

Hearing Group	Approximate TTS Ranges (meters)[1]			
	Sonar Bin LF5M (Low Frequency Sources <180 dB Source Level)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	3 (0–4)	3 (0–4)	3 (0–4)	3 (0–4)
Mid-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
High-frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

Table 6-5: Ranges to Temporary Threshold Shift for Sonar Bin MF1 over a Representative Range of Environments Within the Study Area

Hearing Group	Approximate TTS Ranges (meters)[1] Sonar Bin MF1 (e.g., SQS-53 ASW Hull-Mounted Sonar)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	903 (850–1,025)	903 (850–1,025)	1,264 (1,025–2,275)	1,839 (1,275–3,025)
Mid-frequency Cetacean	210 (210–210)	210 (210–210)	302 (300–310)	379 (370–390)
High-frequency Cetacean	3,043 (1,525–4,775)	3,043 (1,525–4,775)	4,739 (2,025–6,275)	5,614 (2,025–7,525)
Otariidae	65 (65–65)	65 (65–65)	106 (100–110)	137 (130–140)
Phocinae	669 (650–725)	669 (650–725)	970 (900–1,025)	1,075 (1,025–1,525)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

Table 6-6: Ranges to Temporary Threshold Shift for Sonar Bin MF4 over a Representative Range of Environments Within the Study Area

Hearing Group	Approximate TTS Ranges (meters)[1] Sonar Bin MF4 (e.g., AQS-22 ASW Dipping Sonar)			
	1 second	30 seconds	60 seconds	120 seconds
Low-frequency Cetacean	77 (0–85)	162 (150–180)	235 (220–290)	370 (310–600)
Mid-frequency Cetacean	22 (22–22)	35 (35–35)	49 (45–50)	70 (70–70)
High-frequency Cetacean	240 (220–300)	492 (440–775)	668 (550–1,025)	983 (825–2,025)
Otariidae	8 (8–8)	15 (15–15)	19 (19–19)	25 (25–25)
Phocinae	65 (65–65)	110 (110–110)	156 (150–170)	269 (240–460)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

Table 6-7: Ranges to Temporary Threshold Shift for Sonar Bin MF5 over a Representative Range of Environments Within the Study Area

Hearing Group	*Approximate TTS Ranges (meters)[1]*			
	Sonar Bin MF5 (e.g., SSQ-62 ASW Sonobuoy)			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
Low-frequency Cetacean	10 (0–12)	10 (0–12)	14 (0–18)	21 (0–25)
Mid-frequency Cetacean	6 (0–9)	6 (0–9)	12 (0–13)	17 (0–21)
High-frequency Cetacean	118 (100–170)	118 (100–170)	179 (150–480)	273 (210–700)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Phocinae	9 (8–10)	9 (8–10)	14 (14–16)	21 (21–25)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

Table 6-8: Ranges to Temporary Threshold Shift for Sonar Bin HF4 over a Representative Range of Environments Within the Study Area

Hearing Group	*Approximate TTS Ranges (meters)[1]*			
	Sonar Bin HF4 (e.g., SQS-20 Mine Hunting Sonar)			
	1 second	*30 seconds*	*60 seconds*	*120 seconds*
Low-frequency Cetacean	1 (0–3)	2 (0–5)	4 (0–7)	6 (0–11)
Mid-frequency Cetacean	10 (4–17)	17 (6–35)	24 (7–60)	34 (9–90)
High-frequency Cetacean	168 (25–550)	280 (55–775)	371 (80–1,275)	470 (100–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–1)
Phocinae	2 (0–5)	5 (2–8)	8 (3–13)	11 (4–22)

[1] Ranges to TTS represent the model predictions in different areas and seasons within the Study Area. The zone in which animals are expected to suffer TTS extend from onset-PTS to the distance indicated. The average range to TTS is provided as well as the range from the estimated minimum to the maximum range to TTS in parentheses.

The range to received sound levels in 6-dB steps from five representative sonar bins and the percentage of animals that may exhibit a significant behavioral response under each behavioral response function (or step function in the case of the harbor porpoise) are shown in Table 6-9 through Table 6-13, respectively. See Section 6.4.2.1.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) for details on the derivation and use of the behavioral response functions, thresholds, and the cutoff distances.

Table 6-9: Ranges to a Potentially Significant Behavioral Response for Sonar Bin LF5 Over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa^2-s)	Average Range (m) (Minimum – Maximum)	Probability of Behavioral Response for Sonar Bin LF5M			
		Odontocetes	Mysticetes	Pinnipeds	Beaked Whales
196	0 (0–0)	100%	100%	100%	100%
190	0 (0–0)	100%	98%	99%	100%
184	0 (0–0)	99%	88%	98%	100%
178	1 (1–1)	97%	59%	92%	100%
172	2 (1–2)	91%	30%	76%	99%
166	3 (1–5)	78%	20%	48%	97%
160	7 (1–13)	58%	18%	27%	93%
154	16 (1–30)	40%	17%	18%	83%
148	35 (1–85)	29%	16%	16%	66%
142	81 (1–230)	25%	13%	15%	45%
136	183 (1–725)	23%	9%	15%	28%
130	404 (1–1,525)	20%	5%	15%	18%
124	886 (1–3,025)	17%	2%	14%	14%
118	1,973 (725–5,775)	12%	1%	13%	12%
112	4,472 (900–18,275)	6%	0%	9%	11%
106	8,936 (900–54,525)	3%	0%	5%	11%
100	27,580 (900–88,775)	1%	0%	2%	8%

dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts.

Table 6-10: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF1 Over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa^2-s)	***Average Range (m) (Minimum – Maximum)***	***Probability of Behavioral Response for Sonar Bin MF1***			
		Odontocetes	***Mysticetes***	***Pinnipeds***	***Beaked Whales***
196	109 (100–110)	100%	100%	100%	100%
190	239 (190–250)	100%	98%	99%	100%
184	502 (310–575)	99%	88%	98%	100%
178	1,024 (550–2,025)	97%	59%	92%	100%
172	2,948 (625–5,775)	91%	30%	76%	99%
166	6,247 (625–10,025)	78%	20%	48%	97%
160	11,919 (650–20,525)	58%	18%	27%	93%
154	20,470 (650–62,025)	40%	17%	18%	83%
148	33,048 (725–63,525)	29%	16%	16%	66%
142	43,297 (2,025–71,775)	25%	13%	15%	45%
136	52,912 (2,275–91,525)	23%	9%	15%	28%
130	61,974 (2,275–100,000*)	20%	5%	15%	18%
124	66,546 (2,275–100,000*)	17%	2%	14%	14%
118	69,637 (2,525–100,000*)	12%	1%	13%	12%
112	73,010 (2,525–100,000*)	6%	0%	9%	11%
106	75,928 (2,525–100,000*)	3%	0%	5%	11%
100	78,899 (2,525–100,000*)	1%	0%	2%	8%

dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts.

Table 6-11: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF4 Over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa^2-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin MF4*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	8 (1–8)	100%	100%	100%	100%
190	17 (1–17)	100%	98%	99%	100%
184	34 (1–35)	99%	88%	98%	100%
178	68 (1–75)	97%	59%	92%	100%
172	145 (130–300)	91%	30%	76%	99%
166	388 (270–875)	78%	20%	48%	97%
160	841 (470–1,775)	58%	18%	27%	93%
154	1,748 (700–6,025)	40%	17%	18%	83%
148	3,163 (1,025–13,775)	29%	16%	16%	66%
142	5,564 (1,275–27,025)	25%	13%	15%	45%
136	8,043 (1,525–54,275)	23%	9%	15%	28%
130	17,486 (1,525–65,525)	20%	5%	15%	18%
124	27,276 (1,525–84,775)	17%	2%	14%	14%
118	33,138 (2,775–85,275)	12%	1%	13%	12%
112	39,864 (3,775–100,000*)	6%	0%	9%	11%
106	45,477 (5,275–100,000*)	3%	0%	5%	11%
100	48,712 (5,275–100,000*)	1%	0%	2%	8%

dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts.

Table 6-12: Ranges to a Potentially Significant Behavioral Response for Sonar Bin MF5 Over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa^2-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin MF5*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	0 (0–0)	100%	100%	100%	100%
190	2 (1–3)	100%	98%	99%	100%
184	4 (1–7)	99%	88%	98%	100%
178	14 (1–15)	97%	59%	92%	100%
172	29 (1–30)	91%	30%	76%	99%
166	59 (1–70)	78%	20%	48%	97%
160	133 (1–340)	58%	18%	27%	93%
154	309 (1–950)	40%	17%	18%	83%
148	688 (430–2,275)	29%	16%	16%	66%
142	1,471 (650–4,025)	25%	13%	15%	45%
136	2,946 (700–7,525)	23%	9%	15%	28%
130	5,078 (725–11,775)	20%	5%	15%	18%
124	7,556 (725–19,525)	17%	2%	14%	14%
118	10,183 (725–27,775)	12%	1%	13%	12%
112	13,053 (725–63,025)	6%	0%	9%	11%
106	16,283 (1,025–64,525)	3%	0%	5%	11%
100	20,174 (1,025–70,525)	1%	0%	2%	8%

dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts.

Table 6-13: Ranges to a Potentially Significant Behavioral Response for Sonar Bin HF4 Over a Representative Range of Environments Within the Study Area

Received Level (dB re 1 µPa^2-s)	*Average Range (m) (Minimum – Maximum)*	*Probability of Behavioral Response for Sonar Bin HF4*			
		Odontocetes	*Mysticetes*	*Pinnipeds*	*Beaked Whales*
196	3 (1–6)	100%	100%	100%	100%
190	8 (1–16)	100%	98%	99%	100%
184	17 (1–35)	99%	88%	98%	100%
178	34 (1–90)	97%	59%	92%	100%
172	68 (1–180)	91%	30%	76%	99%
166	133 (12–430)	78%	20%	48%	97%
160	255 (30–750)	58%	18%	27%	93%
154	439 (50–1,525)	40%	17%	18%	83%
148	694 (85–2,275)	29%	16%	16%	66%
142	989 (110–3,525)	25%	13%	15%	45%
136	1,378 (170–4,775)	23%	9%	15%	28%
130	1,792 (270–6,025)	20%	5%	15%	18%
124	2,259 (320–7,525)	17%	2%	14%	14%
118	2,832 (320–8,525)	12%	1%	13%	12%
112	3,365 (320–10,525)	6%	0%	9%	11%
106	3,935 (320–12,275)	3%	0%	5%	11%
100	4,546 (320–16,775)	1%	0%	2%	8%

dB re 1 µPa2 - s: decibels referenced to 1 micropascal squared second; m: meters

* Indicates maximum range to which acoustic model was run, a distance of approximately 100 kilometers from the sound source.

Note: Cells are shaded if the mean range value for the specified received level exceeds the distance cutoff range for a particular hearing group. Any impacts within the cutoff range for a criteria group are included in the estimated impacts.

6.4.2.3 Impacts from Sonar and Other Transducers Under the Proposed Action

Sonar and other transducers emit sound waves into the water to detect objects, safely navigate, and communicate. Use of sonar and other transducers would typically be transient and temporary. General categories and characteristics of sonar systems and the number of hours these sonars would be operated during training and testing under the Proposed Action are described in Section 1.4.1 (Acoustic Stressors). Activities using sonars and other transducers would be conducted as described in Section 1.5 (Proposed Action) and Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS. The major aspects of the Proposed Action for the purposes of analyzing impacts to marine mammals are:

- Under the Proposed Action, for training, the number of major training exercises and Civilian Port Defense activities would fluctuate annually. In addition, a portion of training requirements would be met synthetically. Training activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within 200 NM of shore in Navy Operating Areas, on Navy range complexes, on Navy testing ranges, or around inshore locations identified in Section 1.5 (Proposed Action).

- Under the Proposed Action, for testing, the number of testing activities would fluctuate annually. Testing activities using sonar and other transducers could occur throughout the Study Area, although use would generally occur within Navy range complexes, on Navy testing ranges, or around inshore locations identified in Section 1.5 (Proposed Action).

Major training events (Composite Training Unit Exercise, Rim of the Pacific Exercise) are multi-day exercises that transition across large areas and involve multiple anti-submarine warfare assets. It is important to note that while major training exercises focus on anti-submarine warfare, there are significant periods when active anti-submarine warfare sonars are not in use. Nevertheless, behavioral reactions are assumed more likely to be significant than during other anti-submarine warfare activities due to the duration (i.e., multiple days) and scale (i.e., multiple sonar platforms) of the major training exercises. Although major training exercises tend to progress to different locations as the event unfolds, some animals could be exposed multiple times over the course of a few days.

Anti-submarine warfare activities also include unit-level training and coordinated/integrated training, and anti-submarine warfare sonar systems would be active when conducting surface ship and submarine sonar maintenance. Submarine and surface ship sonar maintenance activities involve the use of a single system in a limited manner; therefore, significant reactions to maintenance are less likely than with most other anti-submarine warfare activities. Furthermore, sonar maintenance activities typically occur either pierside or within entrances to harbors where higher levels of anthropogenic activity, including elevated noise levels, already exist. Unit level training activities typically involve the use of a single vessel or aircraft and last for only a few hours over a small area of ocean. These unit-level training and sonar maintenance activities are limited in scope and duration; therefore, significant behavioral reactions are less likely than with other anti-submarine warfare activities with greater intensity and duration. Unit level training activities are more likely to occur close to homeports and in the same general locations each time, so resident animals could be more frequently exposed to these types of activities. Coordinated/integrated exercises involve multiple assets and can last for several days transiting across large areas of a range complex. Repeated exposures to some individual marine mammals are likely during coordinated/integrated exercises. However, due to the shorter duration and

smaller footprint compared to major training exercises, impacts from these activities are less likely to be significant with the possible exception of resident animals near homeports or Navy instrumented ranges that may incur some repeated exposures.

Anti-submarine warfare testing activities are typically similar to unit level training. Vessel evaluation testing activities also use the same anti-submarine warfare sonars on ships and submarines. Testing activities that use anti-submarine warfare sonars typically occur in water deeper than approximately 200 m and therefore out of most nearshore habitats where productivity is typically higher (i.e., more food) and many marine mammals have higher abundances. Therefore, significant reactions to anti-submarine warfare and vessel evaluation testing activities are less likely than with larger anti-submarine warfare training activities discussed above. Anti-submarine warfare and vessel evaluation testing activities are more likely to occur close to homeports and in the same general locations each time, so resident animals could be more frequently exposed to these types of activities. These testing activities are limited in scope and duration; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Mine warfare training activities typically involve a ship, helicopter, or unmanned vehicle using a mine-hunting sonar to locate mines. Most mine warfare sonar systems have a lower source level, higher-frequency, and narrower, often downward facing beam pattern as compared to most anti-submarine warfare sonars. Significant reactions in marine mammals have not been reported due to exposure to mine warfare sonars. While individual animals could show short-term and minor responses to mine warfare sonar training activities, these reactions are very unlikely to lead to any costs or long-term consequences for individuals or populations.

Mine warfare testing activities typically involve a ship, helicopter, or unmanned vehicle testing a mine-hunting sonar system. Unmanned underwater vehicle testing also employs many of the same sonar systems as mine warfare testing and usually involves only a single sonar platform (i.e., unmanned underwater vehicle). Most of the sonar systems and other transducers used during these testing activities typically have a lower source level, higher-frequency, and narrower, often downward facing beam pattern as compared to most anti-submarine warfare sonars. Significant reactions in marine mammals have not been reported due to exposure to these types of systems sonars. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Navigation and object detection activities typically employ ship and submarine based sonar systems and other transducers to navigate and avoid underwater objects. Significant reactions in marine mammals have not been reported due to exposure to most of the sonars and other transducers typically used in these activities. Some hull-mounted anti-submarine warfare sonars (e.g., Bin MF1) have a mode to look for objects in the water such as mines, but this mode uses different source characteristics as compared to the anti-submarine warfare mode. Significant behavioral reactions have not been observed in relation to hull-mounted sonars using object-detection mode, however significant reactions may be more likely than for all other sonar systems and transducers used within these activities due to the additional presence of a moving vessel and higher source levels. Individual animals could show short-term and minor-to-moderate responses to these systems, although these reactions are very unlikely to lead to any costs or long-term consequences for individuals or populations.

Acoustic and Oceanographic Science and Research uses a number of different sonar systems and other transducers to sense and measure the parameters of the ocean (e.g., temperature) and conduct research on the ways sound travels underwater. Many of these systems generate only moderate sound levels and are stationary. Significant reactions in marine mammals have not been reported due to exposure to the sonars and other transducers typically used in these activities. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Other testing activities include testing of individual sonar systems and other transducers for performance and acoustic signature. Most sources used during these events have moderate source levels between 160 and 200 dB re 1 µPa @ 1m and are used for a limited duration, up to a few hours in most cases. Significant reactions in marine mammals have not been reported due to exposure to the sonars and other transducers typically used in these activities. Animals are most likely to show short-term and minor to moderate responses to these testing activities; therefore, many of the impacts estimated by the quantitative analysis are unlikely to rise to the level of a significant behavioral response.

Surface warfare activities require limited use of sonar or other transducers as compared to other types of activities discussed above, typically limited to the sonar targeting system of a few torpedoes. The limited scope and duration of sonar use in these activities makes significant behavioral reactions less likely than with other activities that use anti-submarine warfare sonar systems and other transducers, which are discussed above.

6.4.2.3.1 Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts to marine mammals from sonars and other transducers (Section 6.4.1.6.1, Methods for Analyzing Impacts from Sonars and Other Transducers) are discussed below. The numbers of potential impacts estimated for individual species and stocks of marine mammals from exposure to sonar for training and testing activities are shown in Appendix E (Estimated Marine Mammal and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities) of the HSTT Draft EIS/OEIS and presented below in figures for each species of marine mammal with any estimated effects (e.g., Figure 6-13). The Activity Categories that are most likely to cause impacts and the most likely region in which impacts could occur are represented in the bar charts of each figure. There is a potential for impacts to occur anywhere within the Study Area where sound from sonar and the species overlap, although only Regions or Activity Categories where 0.5 percent of the impacts or greater are estimated to occur are graphically represented on the bar charts below. All (i.e., grand total) estimated impacts for that species are included in the bar plots, regardless of region or category.

Regions within the HSTT Study Area include (see Study Area maps Chapter 2) the Hawaii OPAREA, the Temporary Hawaii OPAREA, the SOCAL Defined Training Areas, the Western SOCAL OPAREA, and the Transit Lane. The SOCAL portion of the HSTT Study Area encompasses the SOCAL Defined Training Areas that are located within approximately 200 NM of the coast and the Western SOCAL OPAREA, which extends westward beyond 200 NM. Similarly, the Hawaii Range Complex portion of the HSTT Study Area is divided into the Hawaii OPAREA that is located around the main Hawaiian Islands within about 200 NM and the Temporary Hawaii OPAREA that extends to the northwest beyond about 200 NM.

Note that the numbers of activities planned can vary from year-to-year, however, results are presented for a "maximum sonar use year". The number of hours these sonars would be operated under the Proposed Action are described in Section 1.4.1 (Acoustic Stressors).

It is important to note when examining the results of the quantitative analysis that the behavioral response functions used to predict the numbers of reactions in this analysis are largely derived from several studies (see Section 6.4.1.5, Behavioral Reactions). These behavioral response studies represent a significant portion of the best available science used for deriving these criteria; however, many of the factors inherent in these studies that potentially increased the likelihood and severity of observed responses (e.g., close approaches by multiple vessels, tagging animals, and vectoring towards animals that have already begun avoiding the sound source) would not occur during Navy activities. Because the Navy purposely avoids approaching marine mammals, many of the behavioral responses estimated by the quantitative analysis are unlikely to occur or unlikely to rise to the severity observed during many of the behavioral response studies.

Although the statutory definition of Level B harassment for military readiness activities under the MMPA requires that the natural behavior patterns of a marine mammal be significantly altered or abandoned, the current state of science for determining those thresholds is somewhat unsettled. Therefore, in its analysis of impacts associated with acoustic sources, the Navy is adopting a conservative approach that overestimates the number of takes by Level B harassment. Many of the responses estimated using the Navy's quantitative analysis are most likely to be moderate severity. Moderate severity responses would be considered significant if they were sustained for a duration long enough that it caused an animal to be outside of normal daily variations in feeding, reproduction, resting, migration/movement, or social cohesion. As discussed in section 6.4.1.5, the behavioral response functions used within the Navy's quantitative analysis were primarily derived from experiments using short-duration sound exposures lasting, in many cases, for less than 30 minutes. If animals exhibited moderate severity reactions for the duration of the exposure or longer, then it was conservatively assumed that the animal experienced a significant behavioral reaction. However the experiments did not include measurements of costs to animals beyond the immediately observed reactions, and no direct correlations exist between an observed behavioral response and a cost that may result in long-term consequences. Within the Navy's quantitative analysis, many behavioral reactions are estimated from exposure to sound that may exceed an animal's behavioral threshold for only a single exposure to several minutes. It is likely that many of the estimated behavioral reactions within the Navy's quantitative analysis would not constitute significant behavioral reactions; however, the numbers of significant verses non-significant behavioral reactions are currently impossible to predict. Consequently, there is a high likelihood that significant numbers of marine mammals exposed to acoustic sources are not significantly altering or abandoning their natural behavior patterns. As such, the overall impact of acoustic sources from military readiness activities on marine mammal species and stocks is negligible, i.e., cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stocks through effects on annual rates of recruitment or survival.

6.4.2.3.2 Mysticetes

Mysticetes may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year. Most low- (less than 1 kHz) and mid- (1–10 kHz) frequency sonars and other transducers produce sounds that are likely to be within the hearing range of mysticetes (Section 6.3, Hearing and Vocalization). Some high-frequency sonars (greater than 10 kHz) also produce sounds that should be audible to mysticetes, although only smaller species of mysticetes such as minke

whales are likely to be able to hear higher frequencies, presumably up to 30 kHz. Therefore, some high-frequency sonars and other transducers with frequency ranges between 10 and 30 kHz may also be audible to some mysticetes. If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss is not likely to occur. Impact ranges for mysticetes are discussed under low-frequency cetaceans in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers).

A few behavioral reactions in mysticetes resulting from exposure to sonar could take place at distances of up to 20 km. Behavioral reactions, however, are much more likely within a few kilometers of the sound source. As discussed above in Section 6.4.1.5 (Behavioral Reactions), the quantitative analysis very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions. Research shows that if mysticetes do respond they may react in a number of ways, depending on the characteristics of the sound source, their experience with the sound source, and whether they are migrating or on seasonal grounds (i.e., breeding or feeding). Behavioral reactions may include alerting; breaking off feeding dives and surfacing; or diving or swimming away. Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise sources is located directly on their migration route. Mysticetes disturbed while migrating could pause their migration or route around the disturbance. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Therefore, most behavioral reactions from mysticetes are likely to be short-term and low to moderate severity.

Some mysticetes may avoid larger activities such as a major training exercise as it moves through an area, although these activities generally do not use the same training locations day-after-day during multi-day activities. Therefore, displaced animals could return quickly after the major training exercise finishes. It is unlikely that most mysticetes would encounter a major training exercise more than once per year. In the ocean, the use of sonar and other active acoustic sources is transient and is unlikely to expose the same population of animals repeatedly over a short period except around homeports and fixed instrumented ranges. However, a few behavioral reactions per year by a single individual are unlikely to produce long-term consequences for that individual.

Behavioral research indicates that mysticetes most likely avoid sound sources at levels that would cause any hearing loss (i.e., TTS) (Section 6.4.1.5, Behavioral Reactions). Therefore, it is likely that the quantitative analysis overestimates PTS and TTS in marine mammals because it does not account for animals avoiding sound sources at closer ranges. Mysticetes that do experience PTS or TTS from sonar sounds may have reduced ability to detect biologically important sounds around the frequency band of the sonar until their hearing recovers. Recovery from hearing loss begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial threshold shift. TTS would be recoverable and PTS would leave some residual hearing loss. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the period that a mysticete had hearing loss, social calls from conspecifics could be more difficult to detect or interpret if they fell in the octave band of the sonar frequency. Killer whales are a primary predator of

mysticetes. Some hearing loss could make killer whale calls more difficult to detect at farther ranges until hearing recovers. It is unclear how or if mysticetes use sound for finding prey or feeding; therefore, it is unknown whether hearing loss would affect a mysticete's ability to locate prey or rate of feeding. A single or even a few minor TTS (less than 20 dB of TTS) to an individual mysticete per year are unlikely to have any long-term consequences for that individual.

Research and observations of masking in marine mammals are discussed in Section 6.4.1.4 (Masking). Most anti-submarine warfare sonars and countermeasures use mid-frequency ranges and a few use low frequency ranges. Most of these sonar signals are limited in the temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Some systems operate with higher duty cycles or nearly continuously, but typically use lower power. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant masking in mysticetes. High-frequency (greater than 10 kHz) sonars fall outside of the best hearing and vocalization ranges of mysticetes (see Section 6.3, Hearing and Vocalization). Furthermore, high frequencies (above 10 kHz) attenuate more rapidly in the water due to absorption than do lower frequency signals, thus producing only a small zone of potential masking. High-frequency sonars are typically used for mine hunting, navigation, and object detection (avoidance). Masking in mysticetes due to exposure to high-frequency sonar is unlikely. Potential costs to mysticetes from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively pinging and the effect is over the moment the sound has ceased. By contrast, hearing loss lasts beyond the exposure for a period. Nevertheless, mysticetes that do experience some masking for a short period from low- or mid-frequency sonar may have their ability to communicate with conspecifics reduced, especially at further ranges. However, larger mysticetes (e.g., blue whale, fin whale, sei whale) communicate at frequencies below those of mid-frequency sonar and even most low frequency sonars. Mysticetes that communicate at higher frequencies (e.g., minke whale) may be affected by some short-term and intermittent masking. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. It is unknown whether a masking would affect a mysticete's ability to feed since it is unclear how or if mysticetes use sound for finding prey or feeding. A single or even a few short periods of masking, if it were to occur, to an individual mysticete per year are unlikely to have any long-term consequences for that individual.

Many activities such as submarine under ice certification and most mine hunting exercises use only high-frequency sonars that are not within mysticetes' hearing range; therefore, there were no predicted effects. Section 6.3 (Hearing and Vocalization) discusses low-frequency cetacean (i.e., mysticetes) hearing abilities.

6.4.2.3.2.1 Blue Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-12 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-14).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Portion of the HSTT Study Area in July through October. Navy training activities that use sonar and other transducers could occur year-round within the Study Area although are concentrated on Navy ranges; however, these four feeding areas make up a very small portion of the Southern California Portion of the HSTT Study Area. As discussed above, blue whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts to blue whale feeding behaviors from training with sonar and other transducers are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015a).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of blue whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Blue whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-12 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-14).

As described for mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Portion of the HSTT Study Area in July through October. Navy testing activities that use sonar and other transducers could occur year-round within the Study Area; however, these four feeding areas make up a very small portion of the Southern California Portion of the HSTT Study Area. As discussed above, blue whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts to blue whale feeding behaviors from testing with sonar and other transducers are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015a).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of blue whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.
ASW: Anti-Submarine Warfare; OPAREA: Operating Area; SOCAL: Southern California

Figure 6-12: Blue Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under The Proposed Action

Table 6-14: Estimated Impacts on Individual Blue Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	97%	98%
Central North Pacific	3%	2%

6.4.2.3.2.2 Bryde's Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Bryde's whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-13 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-15).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Bryde's whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Bryde's whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-13 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-15).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Bryde's whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-13: Bryde's Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-15: Estimated Impacts on Individual Bryde's Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	81%	74%
Eastern Tropical Pacific	19%	26%

6.4.2.3.2.3 Fin Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-14 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-16).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

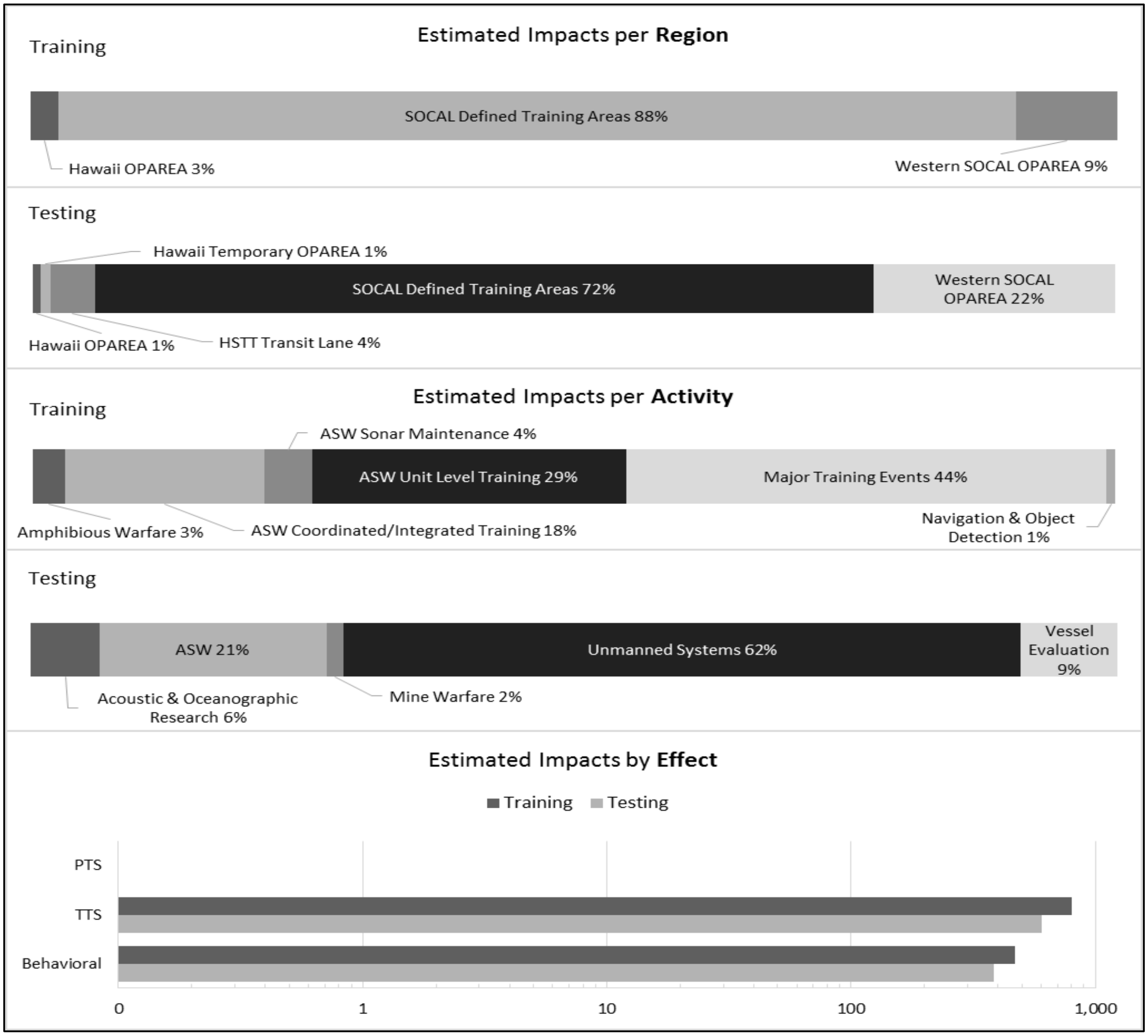
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of fin whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Fin whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-14 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-16).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of fin whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-14: Fin Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-16: Estimated Impacts on Individual Fin Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	97%	98%
Hawaiian	3%	2%

6.4.2.3.2.4 Gray Whales

The vast majority of gray whales in the Study Area are from the non-endangered Eastern North Pacific stock, and all of the modeled impacts are for this stock. On rare occasions Western North Pacific gray whales, which are Endangered Species Act-Listed, occur in the Study.

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Gray whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-15 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to multiple stocks (see Table 6-17).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four migration areas for gray whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap the Southern California Portion of the HSTT Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy training activities that use sonar and other transducers could occur year-round within the Study Area partially overlapping these migration areas. As discussed above, gray whales may either pause their migration until the sound source ceases or moves, or they could route around the source by a couple of kilometers if it was directly in their migratory path. Although, as with most other mysticetes, gray whale reactions to sonar are most likely to be short-term and mild to moderate. Therefore, significant impacts to gray whale migration behaviors from training with sonar and other transducers are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015a).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of gray whales incidental to those activities.

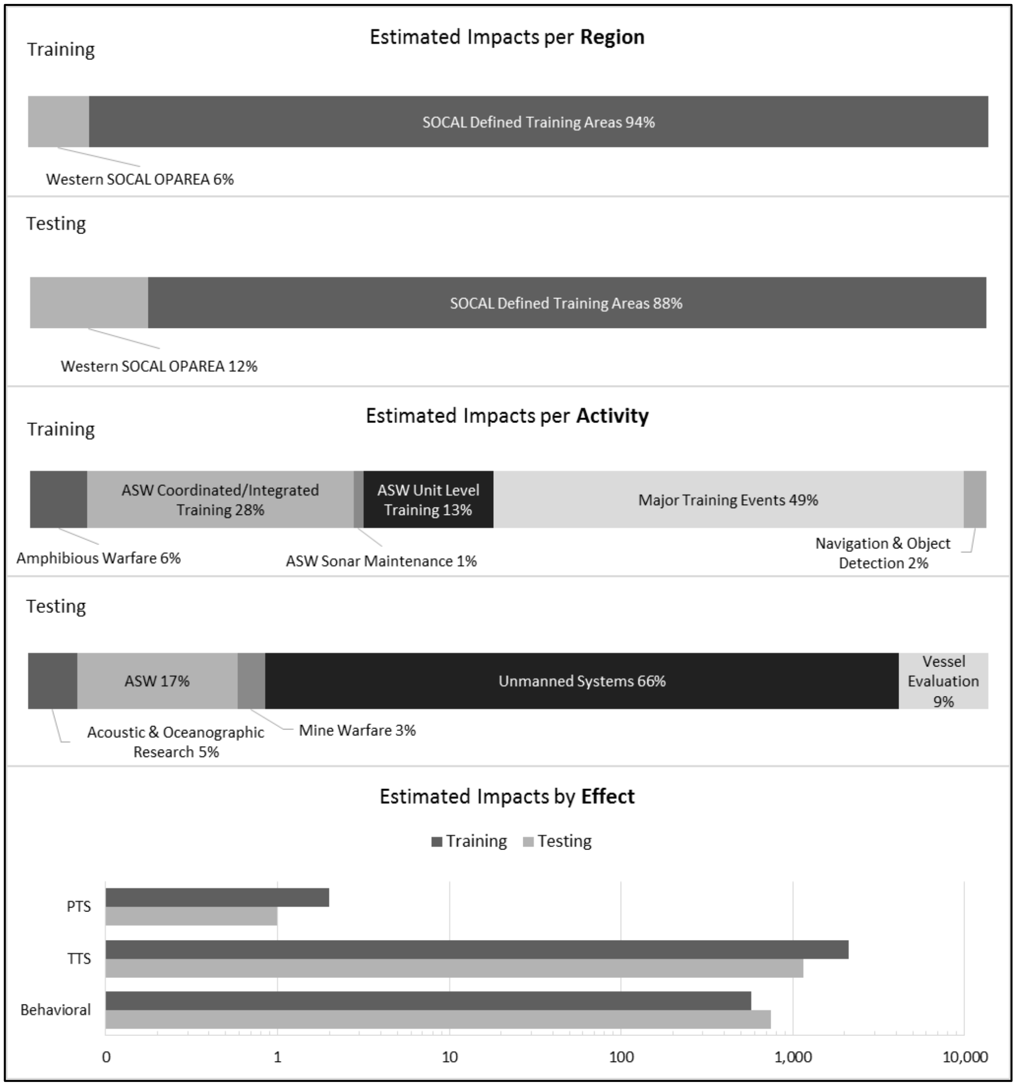
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Gray whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-15 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6 17).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four migration areas for gray whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap the Southern California Portion of the HSTT Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities that use sonar and other transducers could occur year-round within the Study Area partially overlapping these migration areas. As discussed above, gray whales may either pause their migration until the sound source ceases or moves, or they could route around the source by a couple of kilometers if it was directly in their migratory path. Although, as with most other mysticetes, gray whale reactions to sonar are most likely to be short-term and mild to moderate. Therefore, significant impacts to gray whale migration behaviors from testing with sonar and other transducers are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015a).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of gray whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Eastern North Pacific Stock.

Figure 6-15: Gray Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6 17: Estimated Impacts on Individual Gray Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	99.9%	99.9%
Western North Pacific	0.1%	0.1%

6.4.2.3.2.5 Humpback Whales

Impacts have been modeled for the Hawaiian population (Central North Pacific Stock) of humpback whales, which are not Endangered Species Act-Listed, and for the Mexican and Central American populations (California, Oregon, Washington Stock) of humpback whales, which are Endangered Species Act-Listed.

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Humpback whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-16 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (seeTable 6-18).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A seasonal reproduction area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the HSTT Study Area in December through April. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. Sound from sonar or other transducers used outside of the area might expose animals within the identified humpback whale reproduction area identified by Baird et al. (2015). For distant sources, spreading losses in deep water, attenuation over long distances and upslope propagation with the associated bottom losses will likely reduce received levels in the reproductive areas. Some impacts to reproductive behavior could occur due to activities more proximal to the reproductive area. As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors. Therefore, significant impacts to humpback whale reproductive behaviors from training with sonar and other transducers are unlikely to occur within the reproduction area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of humpback whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

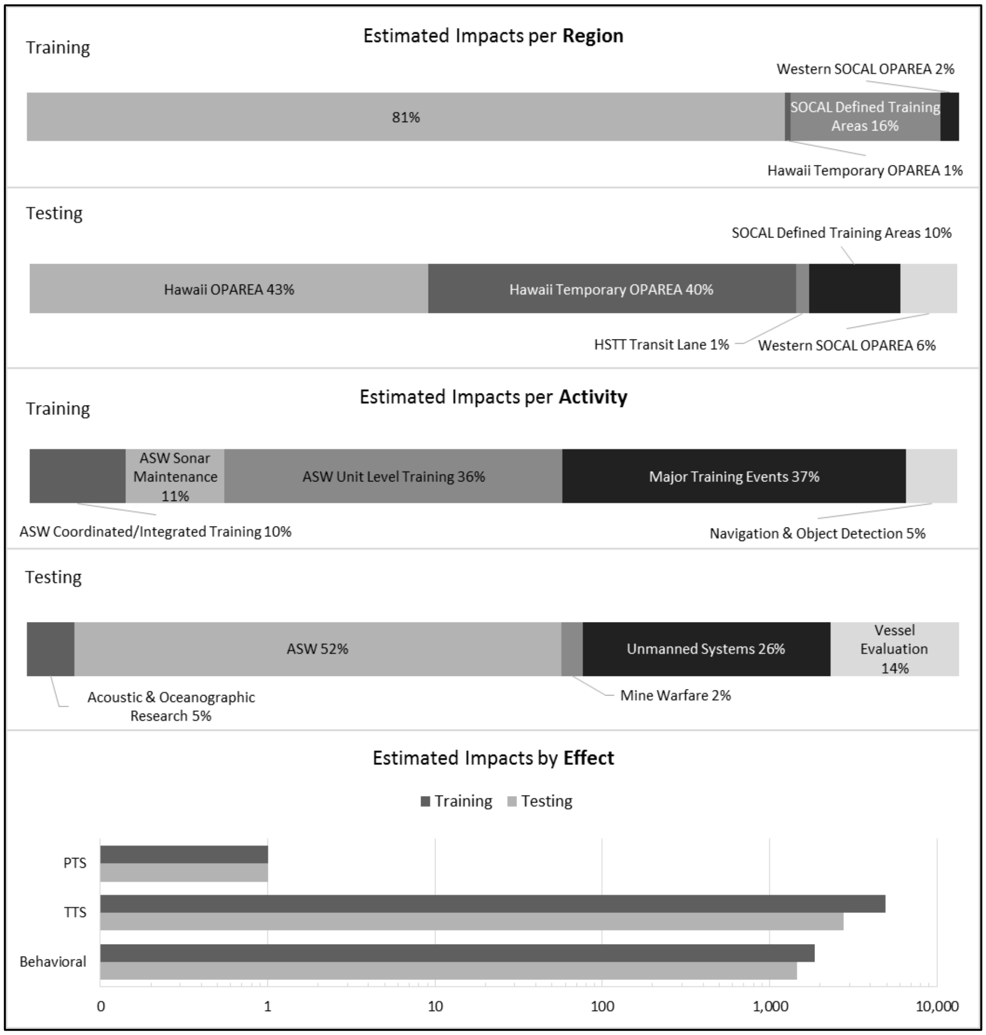
Humpback whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-16 below or Section 5.1 (Incidental Take Request from Acoustic

and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6- 6-18).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A seasonal reproduction area for humpback whales identified by Baird et al. (2015c) overlaps the Hawaii Range Complex within the HSTT Study Area in December through April. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare testing. Sound from sonar or other transducers used outside of the area might expose animals within the identified humpback whale reproduction area identified by Baird et al. (2015). Although propagation from distant sources combined with signal loss from deep-water to shallow water transition would likely mean relatively low receive levels occur within the reproductive area, some impacts to reproductive behavior could occur due to the proximity of the activities to the reproductive areas. As discussed above, humpback whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors. Therefore, significant impacts to humpback whale reproductive behaviors from testing with sonar and other transducers are unlikely to occur within the reproduction area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of humpback whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts.

Figure 6-16: Humpback Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-18: Estimated Impacts on Individual Humpback Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Central America DPS (California, Oregon, & Washington)	9%	7%
Mexico DPS (California, Oregon, & Washington)	10%	11%
Hawaii DPS (Central North Pacific)	82%	83%

6.4.2.3.2.6 Minke Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6 17 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-19).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

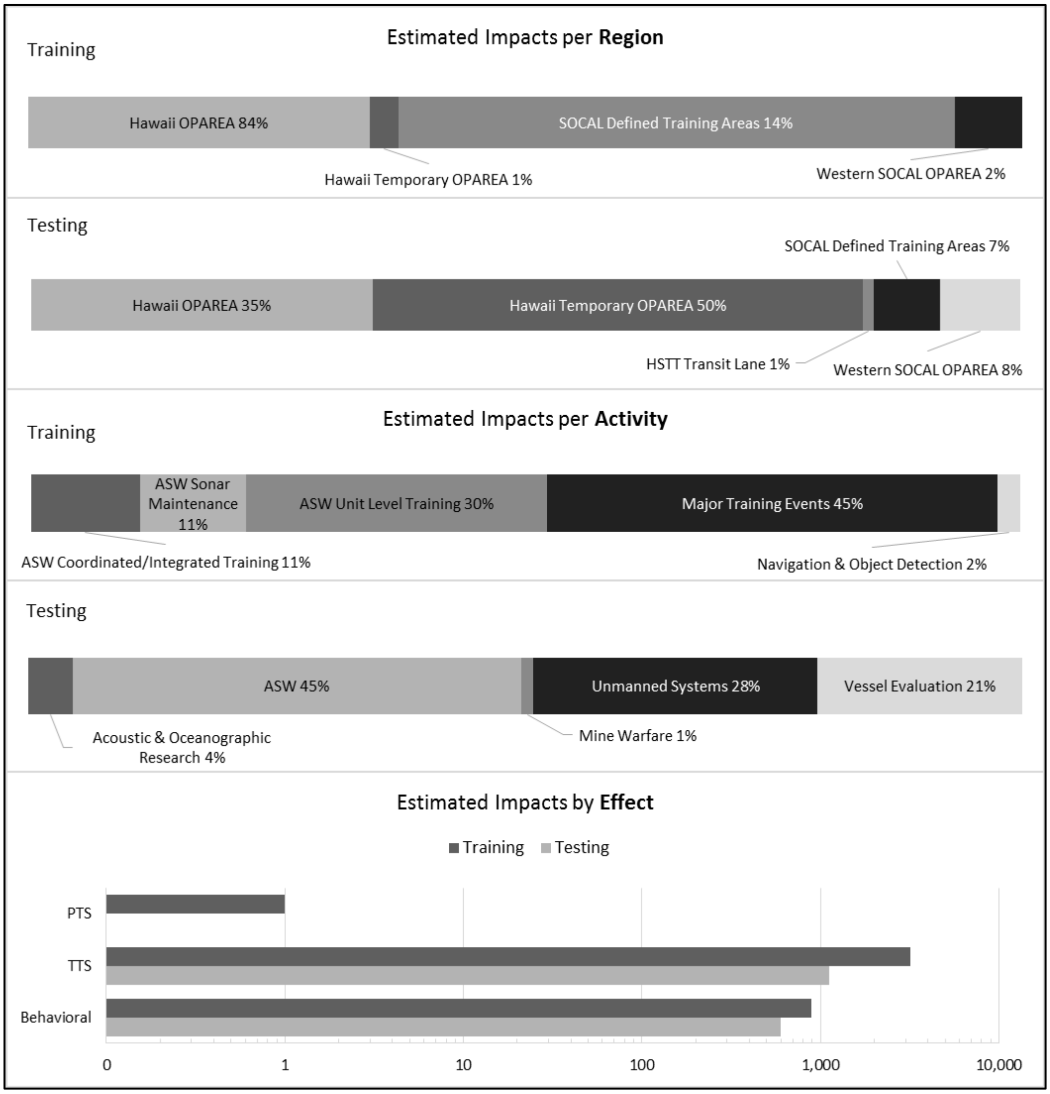
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of minke whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Minke whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6 17 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-19).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of minke whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts.

Figure 6-17: Minke Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-19: Estimated Impacts on Individual Minke Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	16%	16%
Hawaiian	84%	84%

6.4.2.3.2.7 Sei Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-18 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (seeTable 6-20).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of sei whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Sei whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-18 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-20Table 6-).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of sei whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-18: Sei Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-20: Estimated Impacts on Individual Sei Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	69%	65%
Eastern North Pacific	31%	35%

6.4.2.3.3 Odontocetes

Odontocetes may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year. Low- (less than 1 kHz), mid- (1–10 kHz), high-frequency (10–100 kHz), and very high-frequency (100–200 kHz) sonars produce sounds that are likely to be within the audible range of odontocetes (see Section 6.3, Marine Mammal Hearing and Vocalization). If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss could not occur. Impact ranges for odontocetes are discussed under mid-frequency cetaceans in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers).

A few behavioral reactions in odontocetes (except beaked whales and harbor porpoise) resulting from exposure to sonar could take place at distances of up to 20 km. Beaked whales and harbor porpoise have demonstrated a high level of sensitivity to human made noise and activity; therefore, the quantitative analysis assumes that some harbor porpoises and some beaked whales could experience significant behavioral reactions at distance of up to 40 km and 50 km from the sound source, respectively. Behavioral reactions, however, are much more likely within a few kilometers of the sound source for most species of odontocetes such as delphinids and sperm whales. On the other hand, harbor porpoises and beaked whales have generally demonstrated a high level of sensitivity to human made sound and disturbance. Even for harbor porpoise and beaked whales, as discussed above in Section 6.4.2.1.2 (Assessing the Severity of Behavioral Responses from Sonar), the quantitative analysis very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions.

Research shows that if odontocetes do respond they may react in a number of ways, depending on the characteristics of the sound source and their experience with the sound source. Behavioral reactions may include alerting; breaking off feeding dives and surfacing; or diving or swimming away. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Therefore, most behavioral reactions from odontocetes are likely to be short-term and low to moderate severity.

Large odontocetes such as killer whales and pilot whales have been the subject of behavioral response studies (see Section 6.4.1.5). Based on these studies, a number of reactions could occur such as a short-term cessation of natural behavior such as feeding, avoidance of the sound source, or even attraction towards the sound source as seen in pilot whales. Due to the factors involved in Navy training exercises versus the conditions under which pilot whales and killer whales were exposed during behavioral response studies, large odontocetes are unlikely to have more than short-term and moderate severity reactions to sounds from sonar or other human disturbance, and typically only at ranges within a few kilometers. Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit-level exercises and sonar maintenance typically last for a matter of a few hours and involves a limited amount of sonar use so significant responses would be less likely than with longer and more intense exercises (more sonar systems and vessels). Coordinated unit-level anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making a significant response more likely. A single or few short-lived TTS or behavioral reactions per year are unlikely to have any significant costs or long-term consequences for individuals.

Small odontocetes have been the subject of behavioral response studies and observations in the field (see Section 6.4.1.5, Behavioral Reactions). Based on these studies, small odontocetes (dolphins) appear to be less sensitive to sound and human disturbance than other cetacean species. If reactions did occur, they could consist of a short-term behavioral response such as cessation of feeding, avoidance of the sound source, or even attraction towards the sound source. Small odontocetes are unlikely to have more than short-term and moderate severity reactions to sounds from sonar or other human disturbance, and typically only at ranges within a few kilometers. Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit-level exercises and sonar maintenance typically last for a matter of a few hours and involve a limited amount of sonar use so significant responses would be less likely than with longer and more intense exercises (more sonar systems and vessels). Coordinated unit-level anti-submarine warfare exercises involve multiple sonar systems and can last for a period of days, making a significant response more likely. Some bottlenose dolphin estimated impacts could also occur due to navigation and object avoidance (detection) since these activities typically occur entering and leaving Navy homeports that overlap the distribution of coastal populations of this species. Navigation and object avoidance (detection) activities normally involve a single ship or submarine using a limited amount of sonar, therefore significant reactions are unlikely. A single or few short-lived TTS or behavioral reactions per year are unlikely to have any significant costs or long-term consequences for individuals.

Some odontocetes may avoid larger activities such as a major training exercise as it moves through an area, although these activities typically do not use the same training locations day-after-day during multi-day activities. Sensitive species of odontocetes, such as beaked whales, may avoid the area for the duration of the event. Section 6.4.1.5.2 (Behavioral Reactions to Sonar and Other Transducers) discusses these species' observed reactions to sonar and other active acoustic sources. Displaced animals would likely return after the major training exercise subsides within an area, as seen during behavioral response studies in Blainville's beaked whales in the Bahamas (Tyack et al., 2011) and Hawaii (Henderson et al., 2016; Manzano-Roth et al., 2016; Manzano-Roth et al., 2013). Returning to the area would allow the animal to recover from any energy expenditure or missed resources, reducing the likelihood of long-term consequences for the individual. It is unlikely that most animals would encounter a major training exercise more than once per year. Outside of Navy instrumented ranges and homeports, the use of sonar and other active acoustic sources is transient and is unlikely to expose the same population of animals repeatedly over a short period. However, a few behavioral reactions per year from a single individual are unlikely to produce long-term consequences for that individual.

Behavioral research indicates that most odontocetes avoid sound sources at levels that would cause any temporary hearing loss (i.e., TTS) (see Section 6.4.1.2, Hearing Loss and Auditory Injury). TTS and even PTS is more likely for high-frequency cetaceans, such as harbor porpoises and Kogia whales, because hearing loss thresholds for these animals are lower than for all other marine mammals. These species, especially harbor porpoises, have demonstrated a high level of sensitivity to human made sound and activities and may avoid at further distances. This increased distance could avoid or minimize hearing loss for these species as well, especially as compared to the estimates from the quantitative analysis. Therefore, it is likely that the quantitative analysis overestimates TTS and PTS in marine mammals because it does not account for animals avoiding sound sources at closer ranges. Recovery from hearing loss begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial threshold shift. TTS would be

recoverable and PTS would leave some residual hearing loss. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the period that an odontocete had hearing loss, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of odontocetes. Some hearing loss could make killer whale calls more difficult to detect at further ranges until hearing recovers. Odontocetes use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above a few tens of kHz for delphinids, beaked whales, and sperm whales, and above 100 kHz for harbor porpoise and Kogia whales. Therefore, echolocation associated with feeding and navigation in odontocetes is unlikely to be affected by threshold shift at lower frequencies and should not have any significant effect on an odontocete's ability to locate prey or navigate, even in the short-term. Therefore, a single or even a few minor TTS (less than 20 dB of TTS) to an individual odontocete per year are unlikely to have any long-term consequences for that individual. Minor PTS in an individual could have no to minor long-term consequences for individuals.

Research and observations of masking in marine mammals are discussed in Section 6.4.1.4 (Masking). Many anti-submarine warfare sonars and countermeasures use low- and mid-frequency sonar. Most low- and mid-frequency sonar signals (i.e., sounds) are limited in their temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Some systems operate with higher duty cycles or nearly continuously, but typically use lower power. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically much less than one-third octave). These factors reduce the likelihood of sources causing significant masking in odontocetes due to exposure to sonar used during anti-submarine warfare activities. Odontocetes may experience some limited masking at closer ranges from high-frequency sonars and other transducers; however, the frequency band of the sonar is narrow, limiting the likelihood of masking. High frequency sonars are typically used for mine hunting, navigation, and object detection (avoidance). Potential costs to odontocetes from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively pinging and the effect is over the moment the sound has ceased.

Nevertheless, odontocetes that do experience some masking from sonar or other transducers may have their ability to communicate with conspecifics reduced, especially at further ranges. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. As discussed above for TTS, odontocetes use echolocation to find prey and navigate. The echolocation clicks of odontocetes are above the frequencies of most sonar systems, especially those used during anti-submarine warfare. Therefore, echolocation associated with feeding and navigation in odontocetes is unlikely to be masked by sounds from sonars or other transducers. A single or even a few short periods of masking, if it were to occur, to an individual odontocete per year are unlikely to have any long-term consequences for that individual.

6.4.2.3.3.1 Sperm Whales (Endangered Species Act-Listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Sperm whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-19 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-21).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of sperm whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Sperm whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-19 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-21).

As described for other mysticetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of sperm whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-19: Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-21: Estimated Impacts on Individual Sperm Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	45%	58%
Hawaiian	55%	42%

6.4.2.3.3.2 Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales. While impacts to the Hawaii populations of dwarf and pygmy sperm whales are modeled separately, impacts to the California, Oregon and Washington stock of kogia are not broken out by species.

TTS and PTS thresholds for high-frequency cetaceans, such as Kogia whales are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-20 through Figure 6-22 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts of dwarf and pygmy sperm whales apply to the Hawaiian stock. Estimated impacts of Kogia whales (not species specific) apply to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS could reduce an animal’s ability to detect biologically important sounds; however, as discussed above, a small threshold shift due to exposure to sonar is unlikely to affect the hearing range that Kogia whales rely upon. Nevertheless, PTS could have minor long-term consequences for individuals. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for the dwarf sperm whale identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population area only takes up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the dwarf sperm whale small and resident population area identified by Baird et al. (2015c) and impacts to behavior could occur. As discussed above, dwarf sperm whales may be more sensitive to human sounds and activity. Some significant behavioral reactions to sonar within the identified area could occur; however, sound sources at ranges greater than a few kilometers are less likely to lead to significant reactions. A small number of significant behavioral responses from dwarf sperm whales could occur within the small and resident population area identified by Baird et al. (2015c) due to training with sonar and other transducers. However, abandonment of the identified areas by dwarf sperm whales is unlikely to occur because the Navy has been training in these areas with sonar and other transducers for decades.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of dwarf and pygmy sperm whales from

the Hawaiian stock and kogia whales from the California, Oregon and Washington stock incidental to those activities.

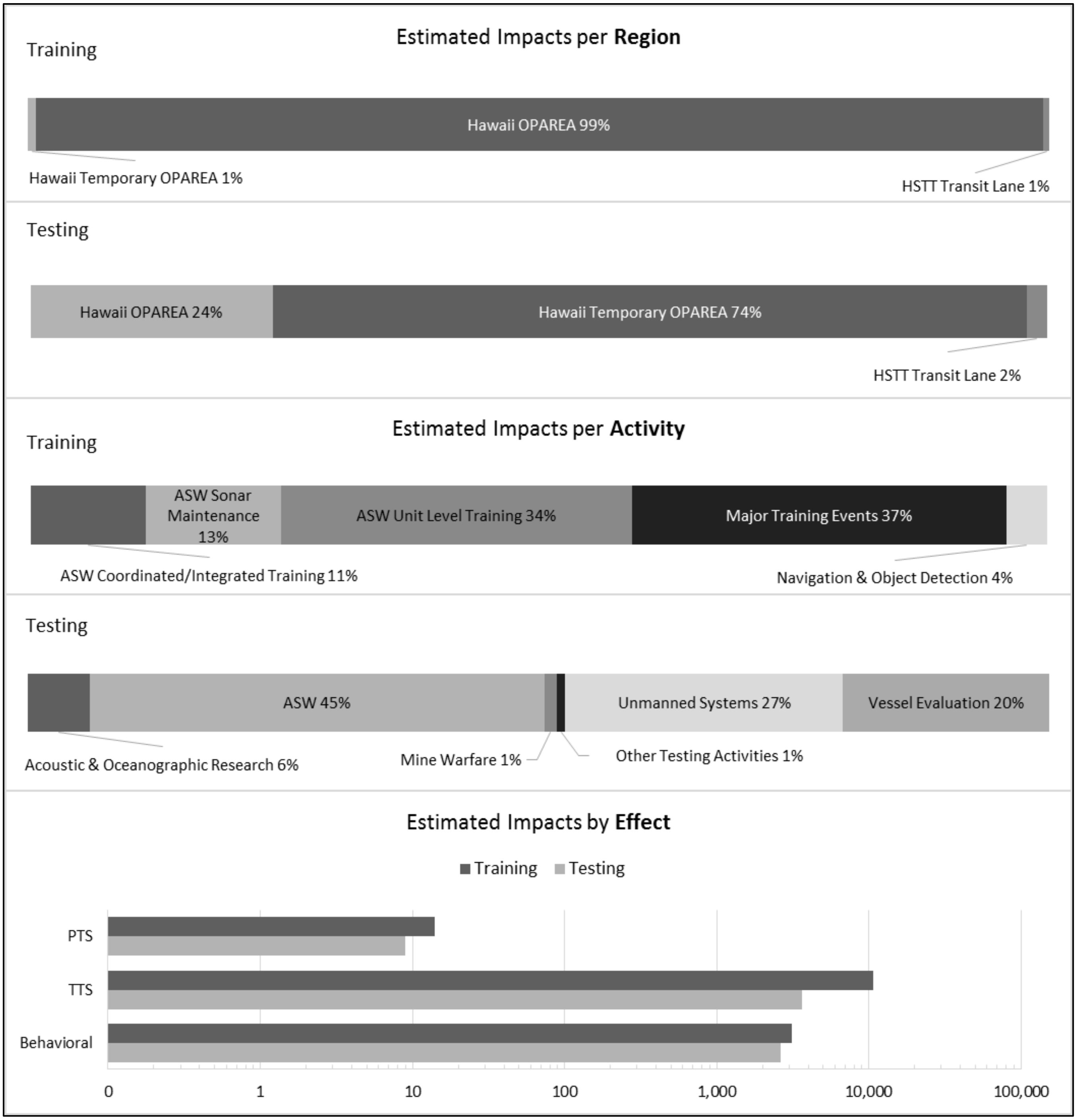
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Kogia whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-20 through Figure 6-22 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts of dwarf and pygmy sperm whales apply to the Hawaiian stock. Estimated impacts of Kogia whales (not species specific) apply to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

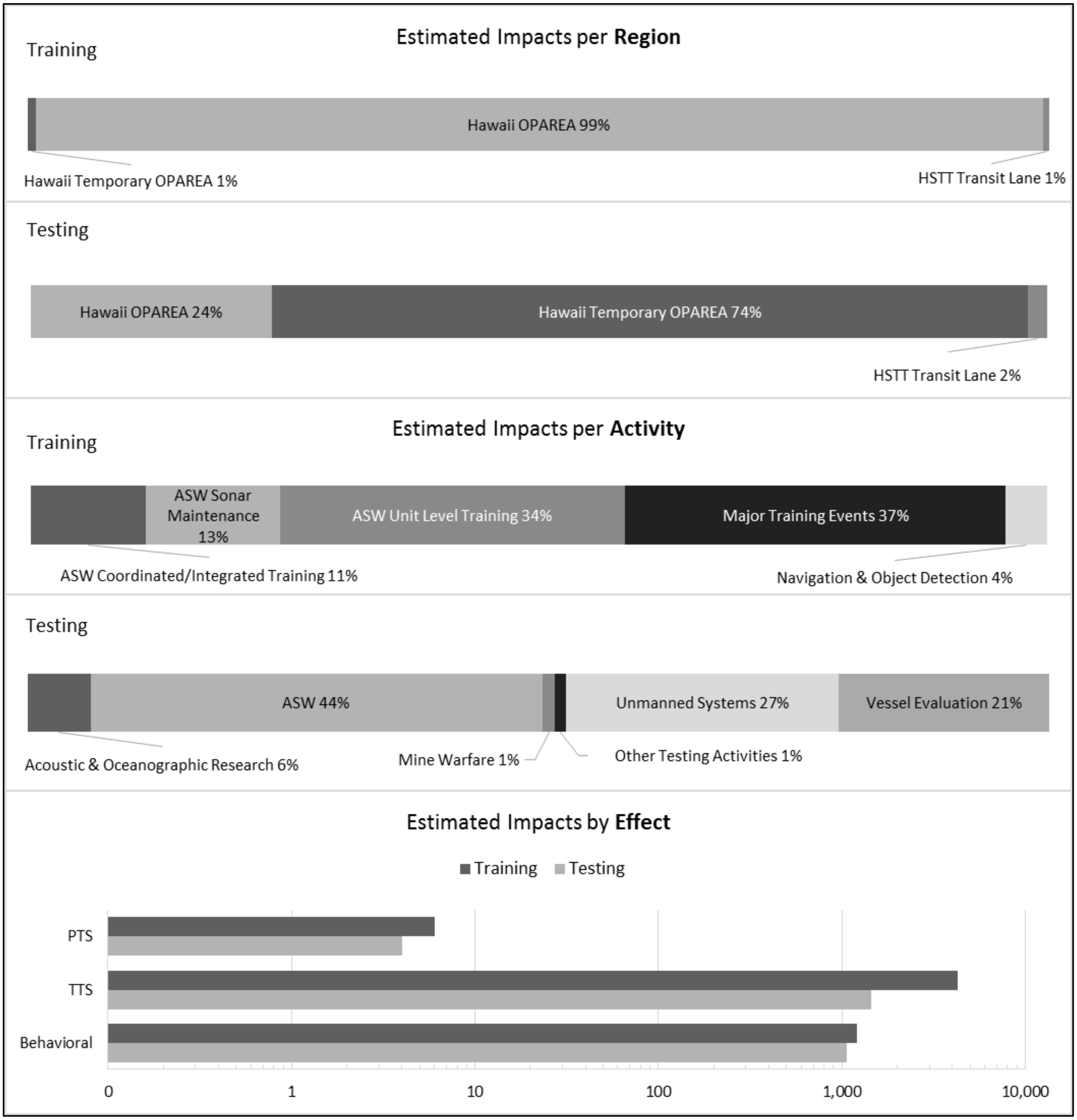
A small and resident population area for the dwarf sperm whale identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population area only takes up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the dwarf sperm whale small and resident population area identified by Baird et al. (2015c) and impacts to behavior could occur. As discussed above, dwarf sperm whales may be more sensitive to human sounds and activity. Some significant behavioral reactions to sonar within the identified area could occur; however, sound sources at ranges greater than a few kilometers are less likely to lead to significant reactions. A small number of significant behavioral responses from dwarf sperm whales could occur within the small and resident population area identified by Baird et al. (2015c) due to testing with sonar and other transducers. However, abandonment of the identified areas by dwarf sperm whales is unlikely to occur because the Navy has been testing in these areas with sonar and other transducers for decades.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of dwarf and pygmy sperm whales from the Hawaiian stock and kogia whales from the California, Oregon and Washington stock incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Hawaiian Stock.

Figure 6-20: Dwarf Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% Hawaiian Stock.

Figure 6-21: Pygmy Sperm Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% California, Oregon, and Washington Stock.

Figure 6-22: Kogia Whales Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.3 Beaked Whales

Beaked whales within the HSTT study area include: Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, Longman's beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale, and the Pygmy beaked whale. Impacts to Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale and the Pygmy beaked whale are combined and represented in the beaked whale guild (Mesoplodon spp.).

As discussed above for odontocetes overall, the quantitative analysis overestimates hearing loss in marine mammals because behavioral response research has shown that most marine mammals are likely to avoid sound levels that could cause more than minor to moderate TTS (6–20 dB). Specifically for beaked whales, behavioral response research discussed below and in Section 6.4.1.5 (Behavioral Reactions) has demonstrated that beaked whales are sensitive to sound from sonars and usually avoid sound sources by 10 or more kilometers. This distance is well beyond the ranges to TTS for mid-frequency cetaceans such as beaked whales. Therefore, any TTS predicted by the quantitative analysis is unlikely to occur in beaked whales.

Research and observations (Section 6.4.1.5, Behavioral Reactions) show that if beaked whales are exposed to sonar or other active acoustic sources they may startle, break off feeding dives, and avoid the area of the sound source at levels ranging between 95 and 157 dB re 1 μPa (McCarthy et al., 2011). Furthermore, in research done at the Navy's fixed tracking ranges in the Bahamas and Hawaii, animals leave the immediate area of the anti-submarine warfare training exercise but return within a few days after the event ends (Manzano-Roth et al., 2013; Tyack et al., 2011). Populations of beaked whales and other odontocetes on Navy fixed ranges that have been operating for decades appear to be stable. Significant behavioral reactions seem likely in most cases if beaked whales are exposed to anti-submarine sonar within a few tens of kilometers, especially for prolonged periods (a few hours or more) since this is one of the most sensitive marine mammal groups to human-made sound of any species or group studied to date.

Based on the best available science, the Navy believes beaked whales that exhibit a significant behavioral reaction due to sonar and other active acoustic training or testing activities would generally not have long-term consequences for individuals or populations. However, because of a lack of scientific consensus regarding the causal link between sonar and stranding events, NMFS has stated in a letter to the Navy dated October 2006 that it "cannot conclude with certainty the degree to which mitigation measures would eliminate or reduce the potential for serious injury or mortality." The Navy does not anticipate that marine mammal strandings or mortality will result from the operation of sonar during Navy exercises within the Study Area. Additionally, through the MMPA process (which allows for adaptive management), NMFS and the Navy will determine the appropriate way to proceed in the event that a causal relationship were to be found between Navy activities and a future stranding.

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-23 through Figure 6-27 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts of Baird's beaked whales and of the beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and

Washington stocks. Estimated impacts of Blainville's beaked whales, Cuvier's beaked whales, and Longman's beaked whales apply only to the Hawaiian stocks.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for Cuvier's beaked whales and small and resident population area for Blainville's beaked whales identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas only take up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the beaked whale small and resident population areas identified by Baird et al. (2015c) and impacts to behavior could occur. As discussed above, beaked whales are some of the most sensitive species studied to sounds from sonars, especially those used during anti-submarine warfare training. Some significant behavioral reactions to sonar are likely within the identified areas; however, sound sources at ranges greater than a few tens of kilometers are less likely to lead to significant reactions. Therefore, some impacts to beaked whale natural behaviors could occur within the small and resident population areas identified by Baird et al. (2015c) due to training with sonar and other transducers. However, abandonment of the identified areas by Cuvier's or Blainville's beaked whales is unlikely to occur because the Navy has been training in these areas with sonar and other transducers for decades.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Baird's, Blainville's, Cuvier's, Longman's, beaked whales and Mesoplodon spp. (species within the beaked whale guild) incidental to those activities.

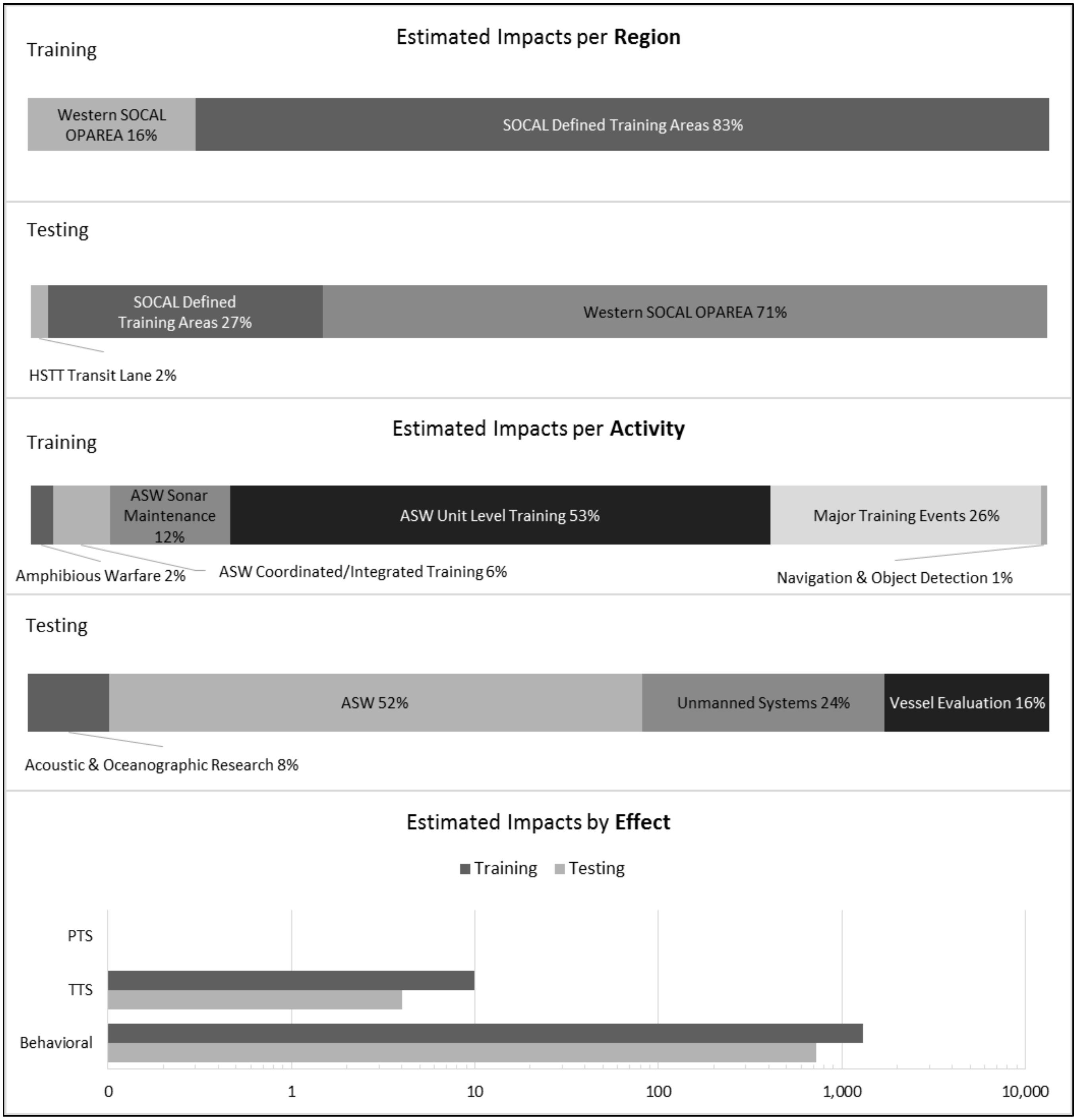
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Beaked whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-23 through Figure 6-27 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts of Baird's beaked whales and of the beaked whale guild (Mesoplodon spp.) apply only to the California, Oregon, and Washington stocks. Estimated impacts of Blainville's beaked whales, Cuvier's beaked whales, and Longman's beaked whales apply only to the Hawaiian stocks.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

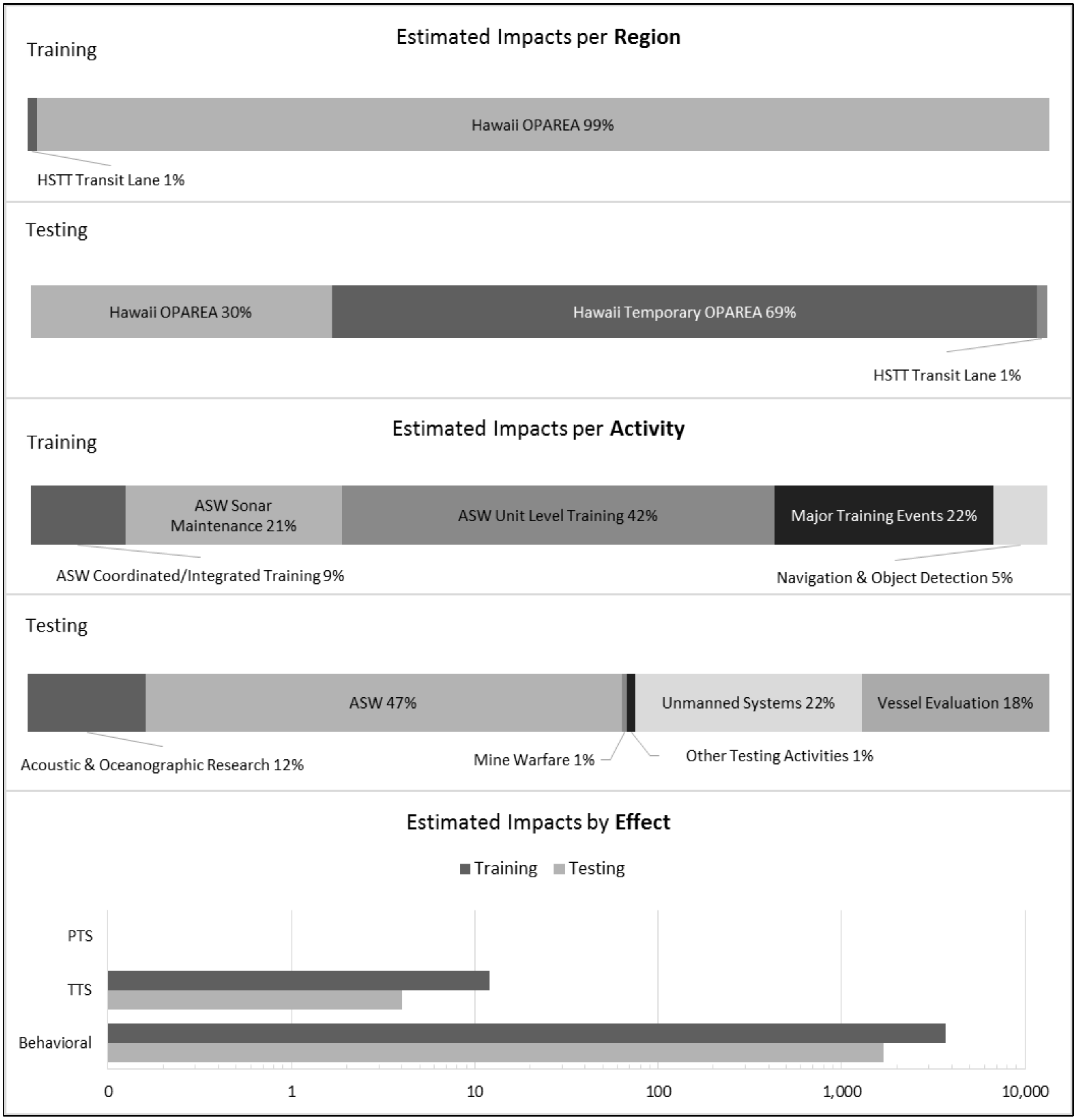
A small and resident population area for Cuvier's beaked whales and small and resident population area for Blainville's beaked whales identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas only take up a very small portion of the Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration. The sound from sonar or other transducers could expose animals within the beaked whale small and resident population areas identified by Baird et al. (2015c) and impacts to behavior could occur. As discussed above, beaked whales are some of the most sensitive species studied to sounds from sonars, especially those used during anti-submarine warfare testing. Some significant behavioral reactions to sonar are likely within the identified areas; however, sound sources at ranges greater than a few tens of kilometers are less likely to lead to significant reactions. Therefore, some impacts to beaked whale natural behaviors could occur within the small and resident population areas identified by Baird et al. (2015c) due to testing with sonar and other transducers. However, abandonment of the identified areas by Cuvier's or Blainville's beaked whales is unlikely to occur because the Navy has been testing in these areas with sonar and other transducers for decades.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Baird's, Blainville's, Cuvier's, Longman's, beaked whales and Mesoplodon spp. (species within the beaked whale guild) incidental to those activities.



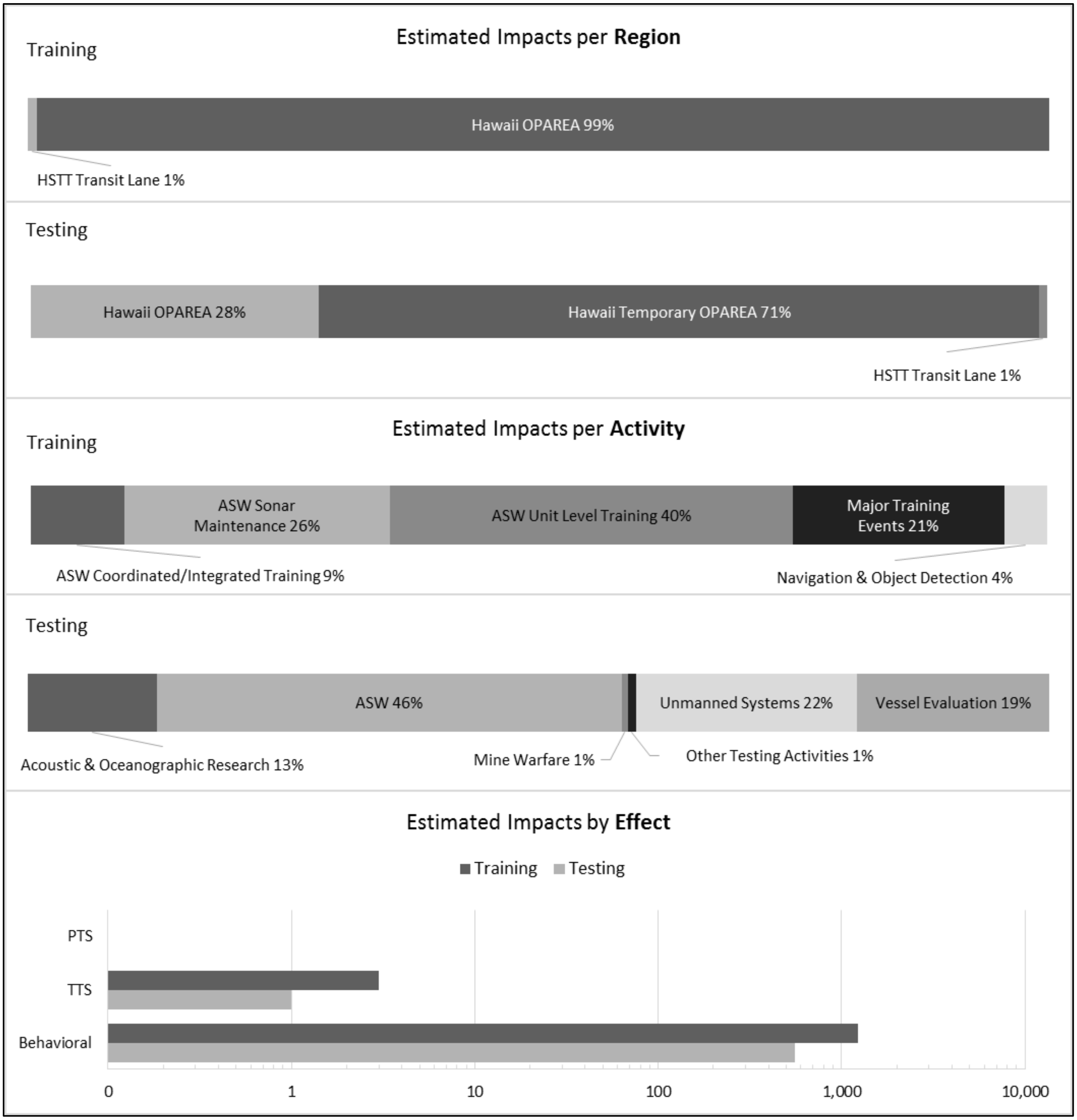
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% California, Oregon, and Washington Stock. ASW: Anti-Submarine Warfare; OPAREA: Operating Area; SOCAL: Southern California

Figure 6-23: Baird's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action



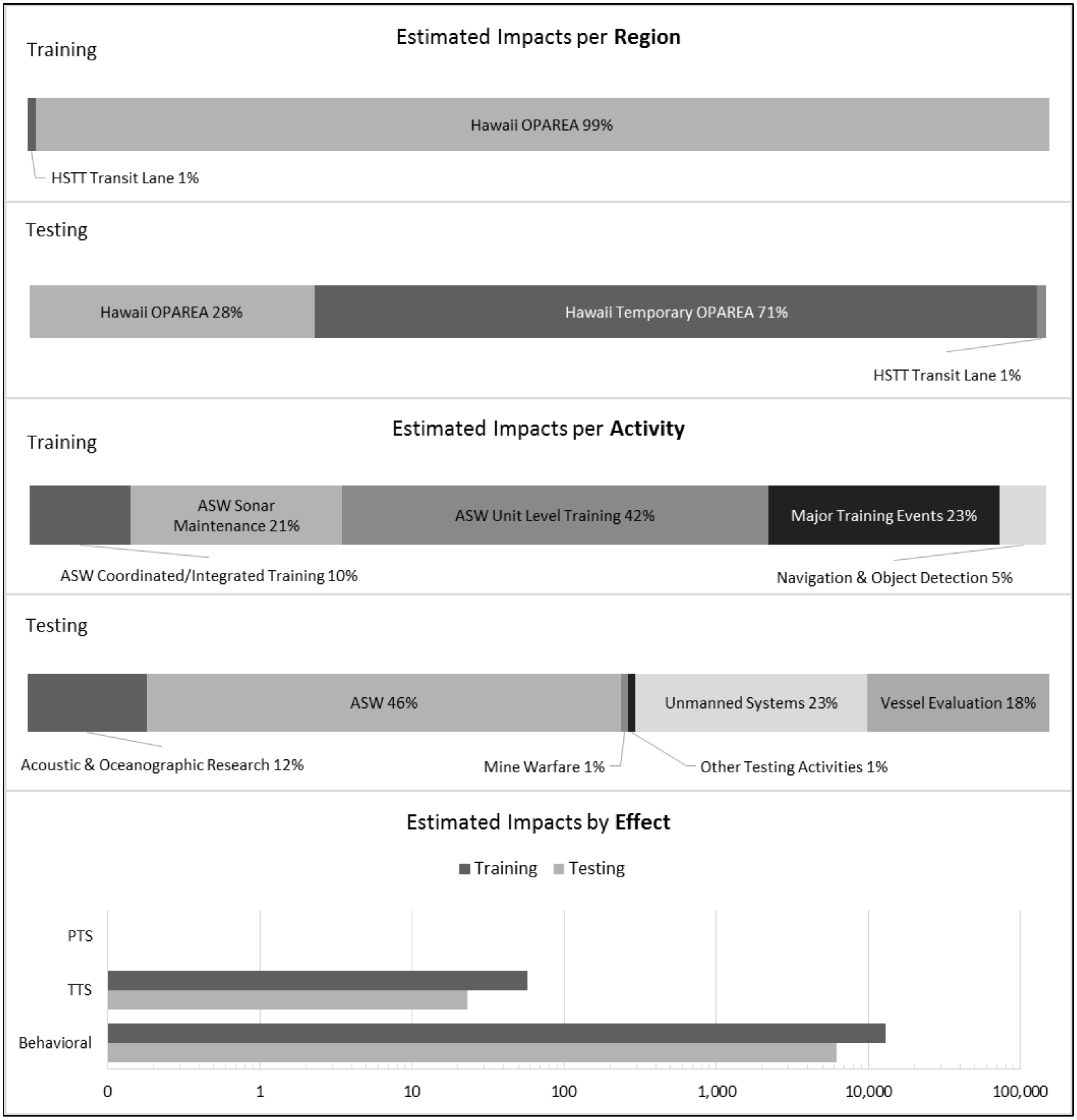
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock.

Figure 6-24: Blainville's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action



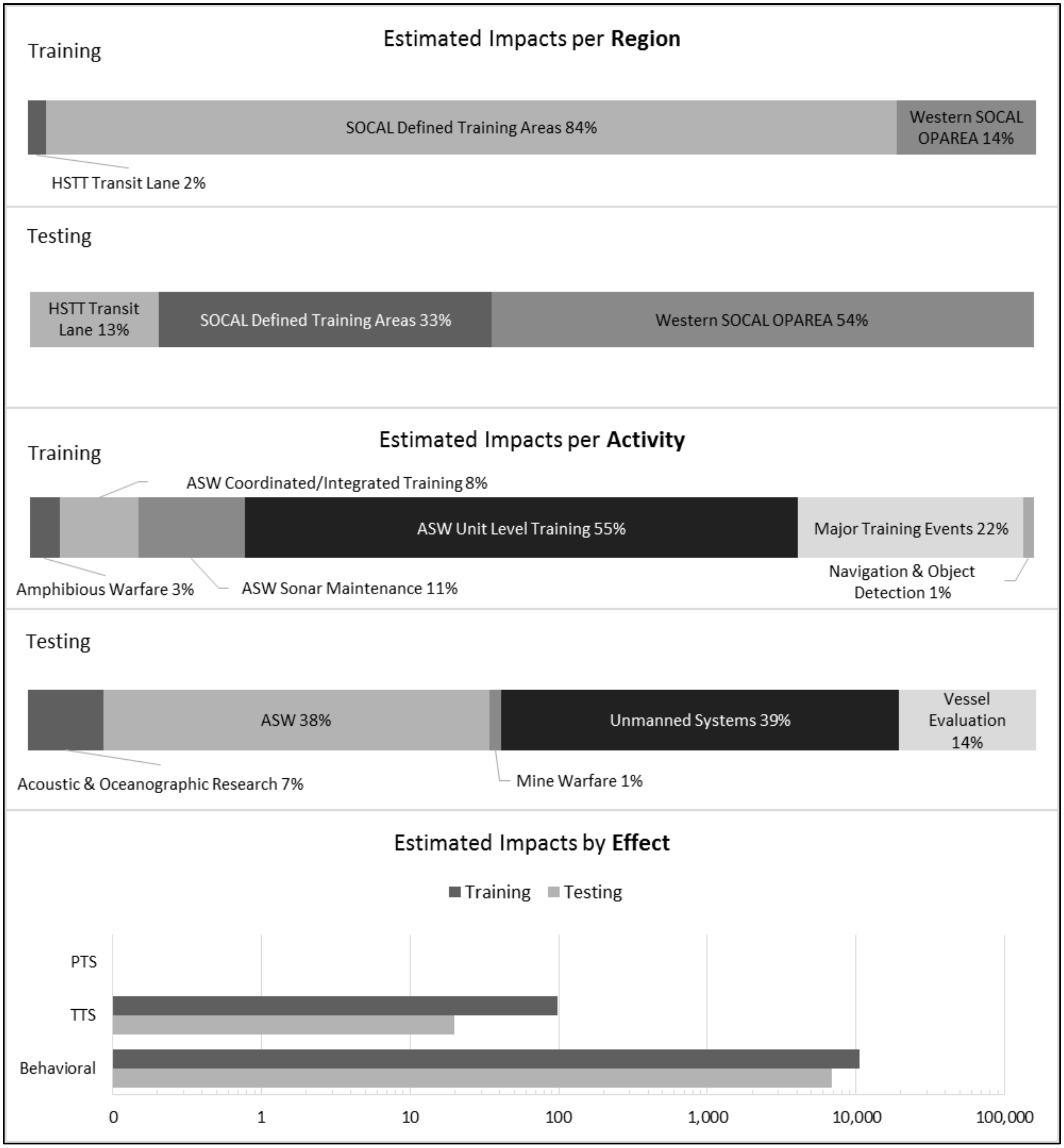
Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock.

Figure 6-25: Cuvier's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock. ASW: Anti-Submarine Warfare; OPAREA: Operating Area; SOCAL: Southern California

Figure 6-26: Longman's Beaked Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% California, Oregon, and Washington Stock.

Figure 6-27: Mesoplodon Spp. (Beaked Whale Guild) Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.4 Bottlenose Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-28 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-22).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant reactions or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, although anti-submarine warfare activities could occur in waters deeper than 200 m around the main Hawaiian Islands, and sonar may be used as ships enter and exit Pearl Harbor. However, sound from sonar or other transducers could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, bottlenose dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to bottlenose dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of bottlenose dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

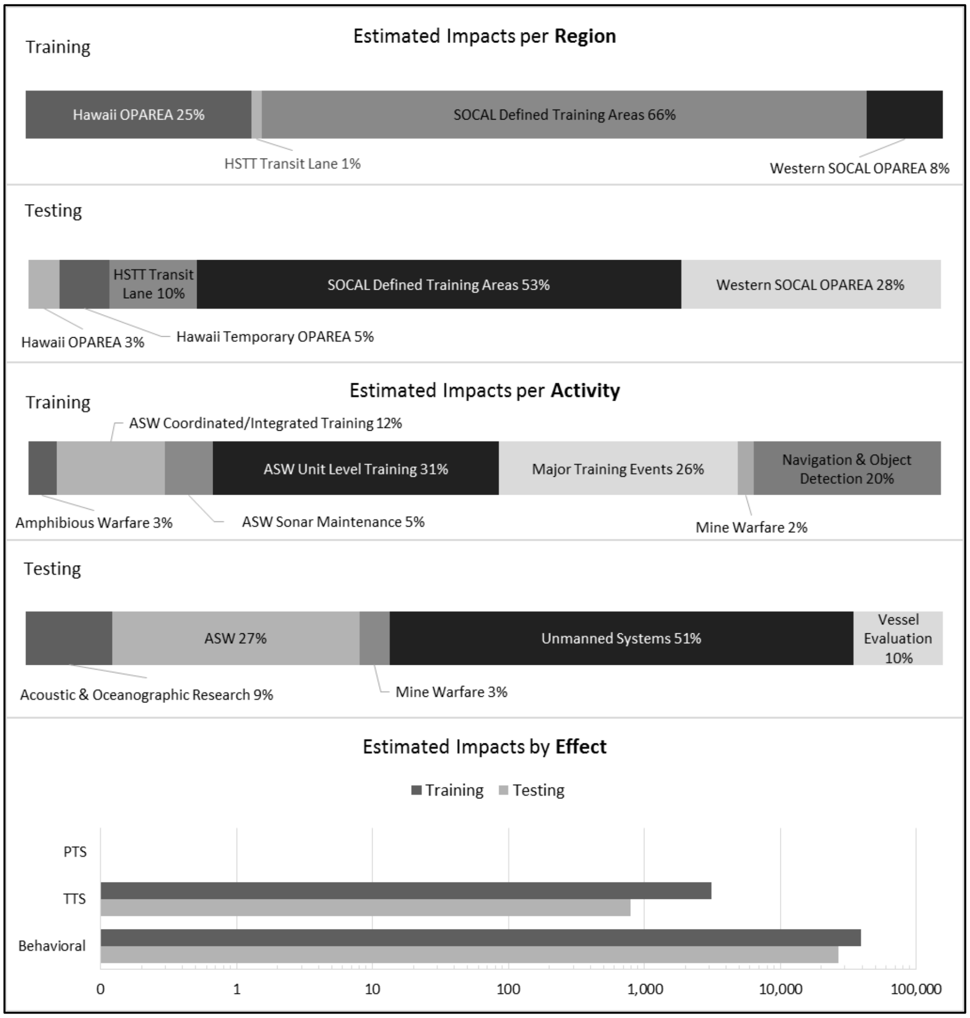
Bottlenose dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-28 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-22).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be

conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, although anti-submarine warfare activities could occur in waters deeper than 200 m around the main Hawaiian Islands, and sonar may be used as ships enter and exit Pearl Harbor. However, sound from sonar or other transducers could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, bottlenose dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to bottlenose dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of bottlenose dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-28: Bottlenose Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-22: Estimated Impacts on Individual Bottlenose Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	1%
California Coastal	0%	6%
California, Oregon, and	75%	85%
Hawaiian Pelagic	5%	5%
Kauai and Niihau	0%	2%
Oahu	19%	2%

6.4.2.3.3.5 False Killer Whales

The Main Hawaiian Islands Insular stock of false killer whales is Endangered Species Act-listed.

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

False killer whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-29 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-23).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for the endangered insular population of false killer whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. However, sound from sonar or other transducers could still expose animals within the false killer whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, false killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to false killer whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of false killer whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

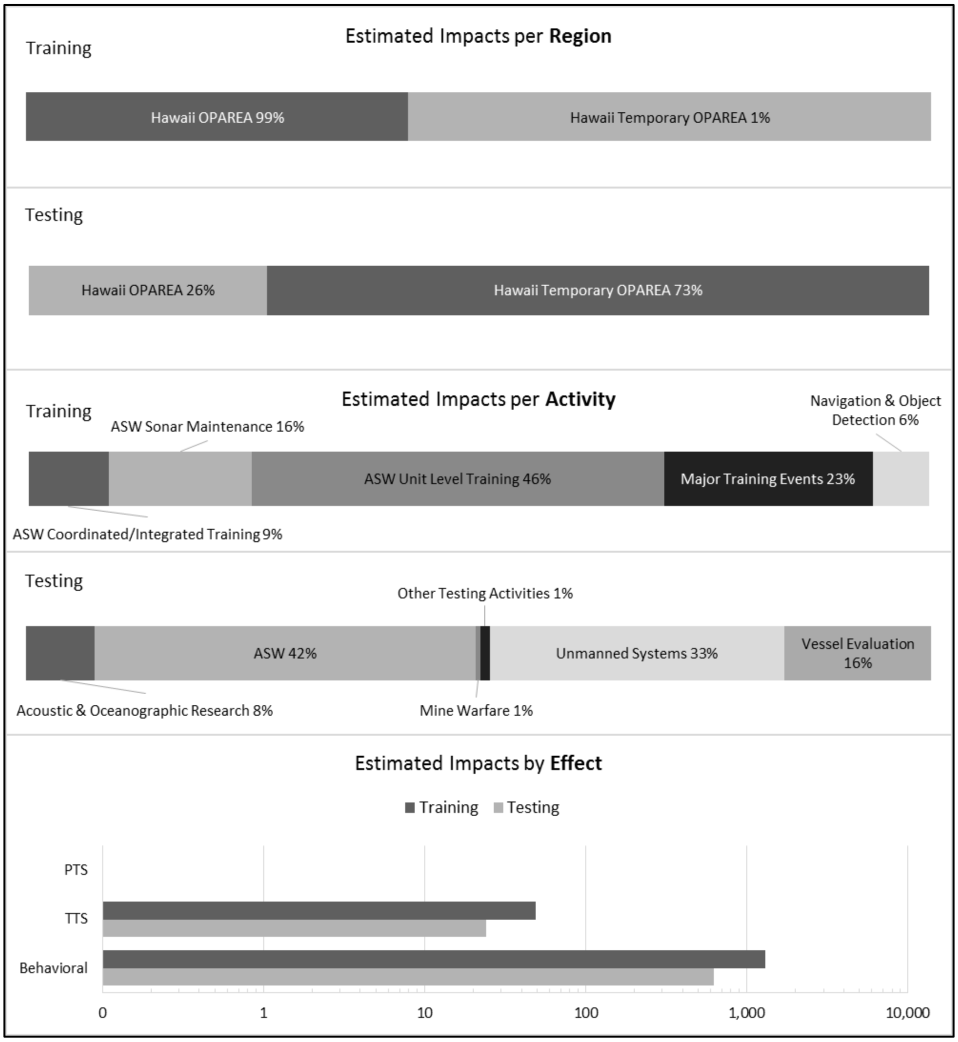
False killer whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-29 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-23).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be

conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for the endangered insular population of false killer whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the false killer whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, false killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to false killer whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of false killer whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-29: False Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-23: Estimated Impacts on Individual False Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	52%	52%
Northwestern Hawaiian Islands	19%	19%
Main Hawaiian Islands Insular	30%	28%

6.4.2.3.3.6 Fraser's Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Fraser's dolphin may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-30 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will not result in the unintentional taking of Fraser's dolphin incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Fraser's dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-30 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Fraser's dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock.

Figure 6-30: Fraser's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.7 Killer Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-31 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-24).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of killer whales incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Killer whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-31 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see seeTable 6-24).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of killer whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-31: Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-24: Estimated Impacts on Individual Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	29%	29%
Eastern North Pacific Offshore	25%	25%
Eastern North Pacific Transient/West Coast Transient	46%	46%

6.4.2.3.3.8 Long-Beaked Common Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Long-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-32 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

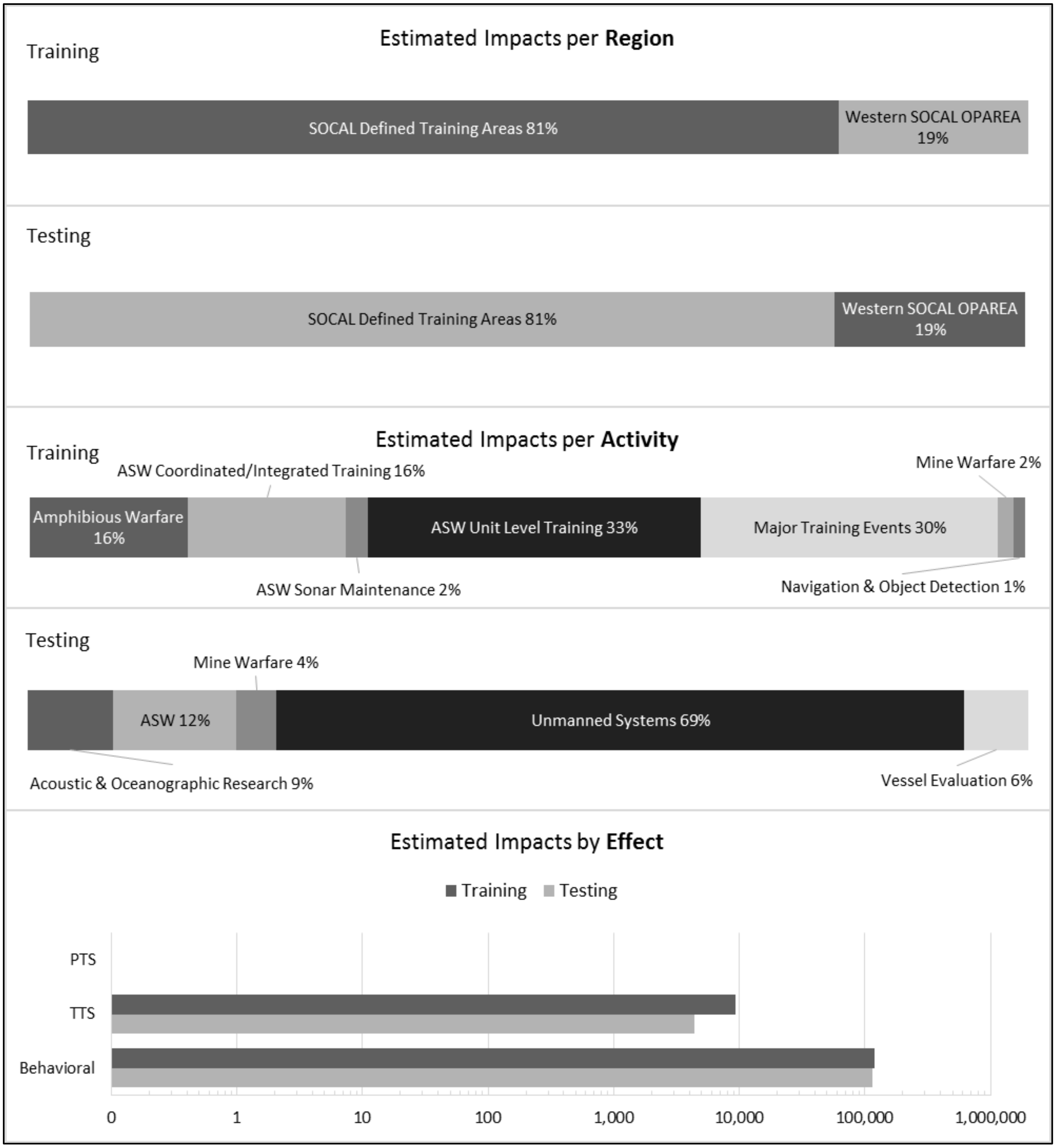
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of long-beaked common dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Long-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-32 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of long-beaked common dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% California Stock.

Figure 6-32: Long-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.9 Melon-Headed Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Melon-headed whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-33 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-25).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not routinely conduct anti-submarine warfare activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. However, sound from sonar or other transducers could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, melon-headed whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to melon-headed whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training or testing activities as described under the Proposed Action will result in the unintentional taking of melon-headed whales incidental to those activities.

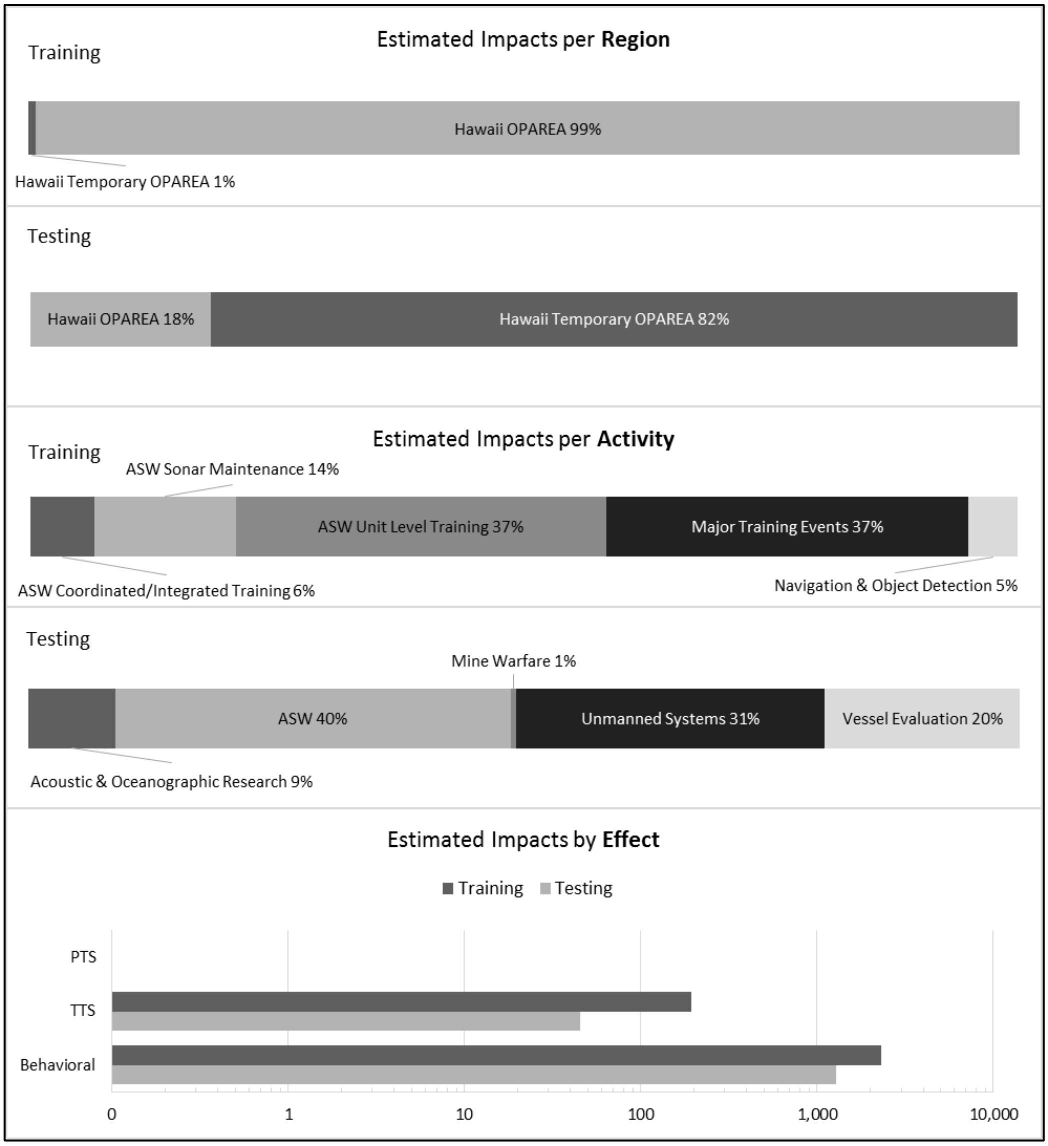
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Melon-headed whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-33 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-25Table 6-).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not routinely conduct antisubmarine warfare activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, melon-headed whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to melon-headed whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of melon-headed whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-33: Melon-Headed Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-25: Estimated Impacts on Individual Melon-Headed Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian Islands	93%	87%
Kohala Resident	7%	13%

6.4.2.3.3.10 Northern Right Whale Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-34 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

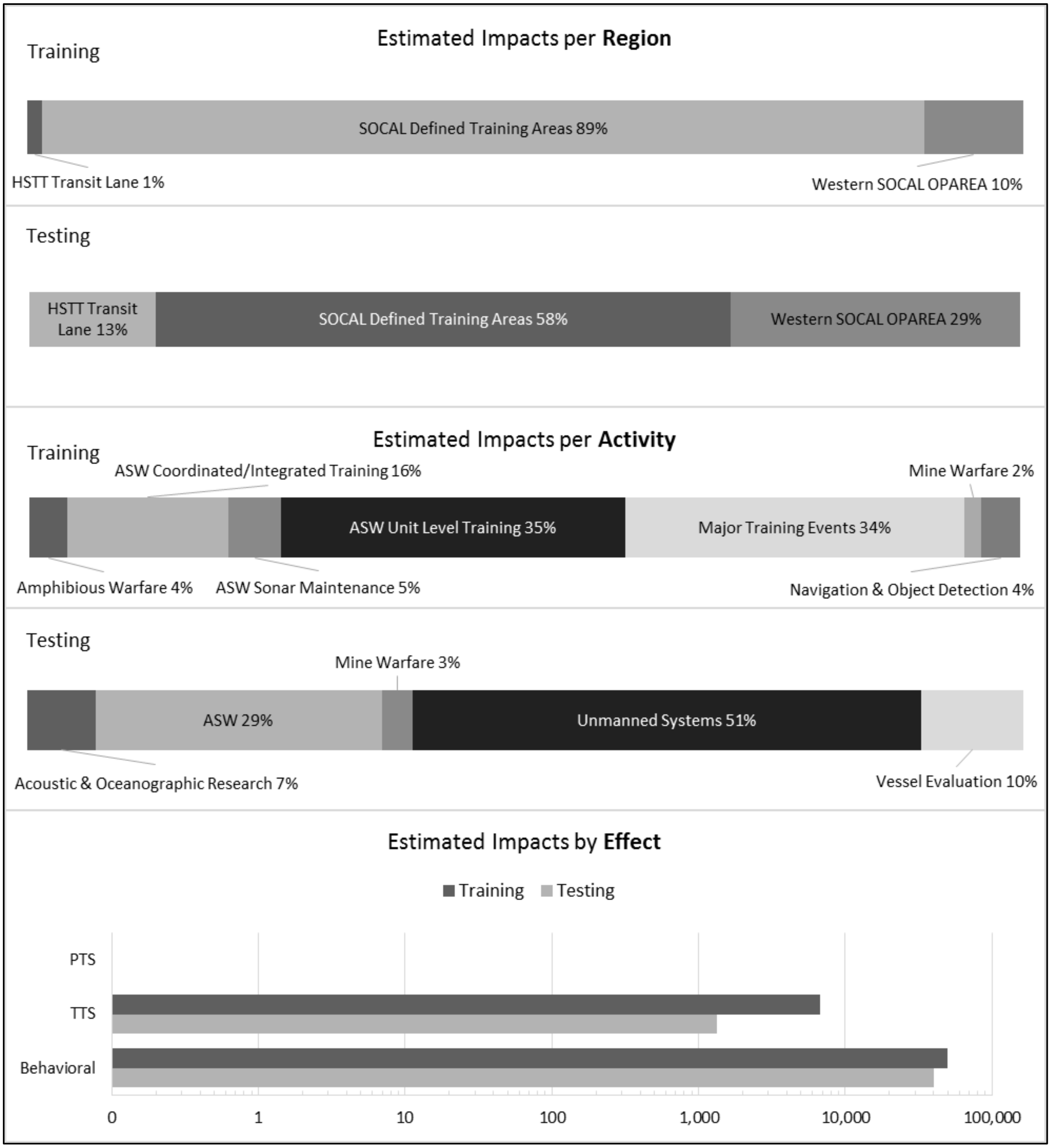
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Northern right whale dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Northern right whale dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-34 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Northern right whale dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.
100% California, Oregon, and Washington Stock.

Figure 6-34: Northern Right Whale Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.11 Pacific White-Sided Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-35 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

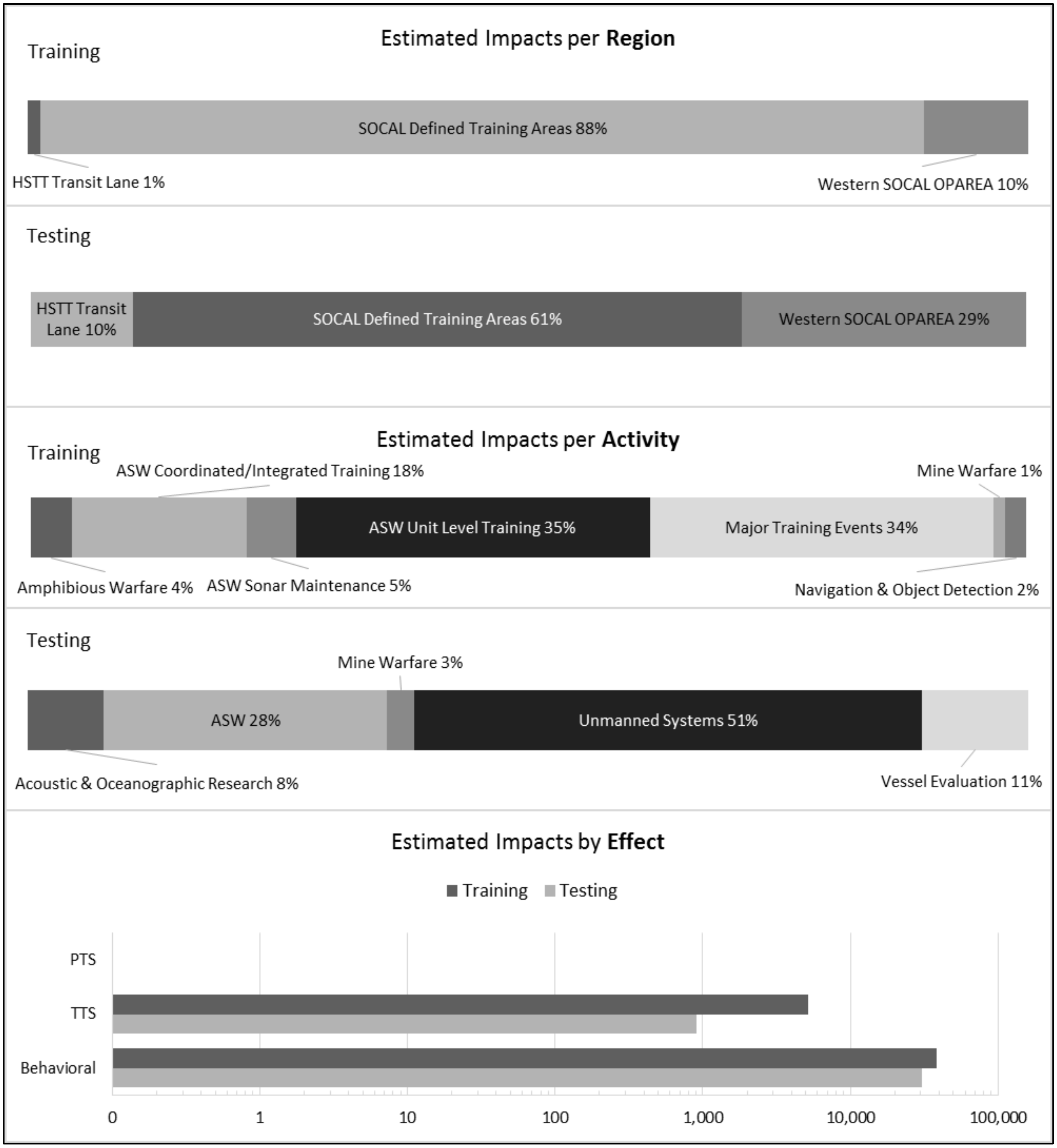
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Pacific white-sided dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-35 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.
100% California, Oregon, and Washington Stock.

Figure 6-35: Pacific White-Sided Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.12 Pantropical Spotted Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Pantropical spotted dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-36 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-26).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. However, sound from sonar or other transducers could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, pantropical spotted dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pantropical spotted dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.

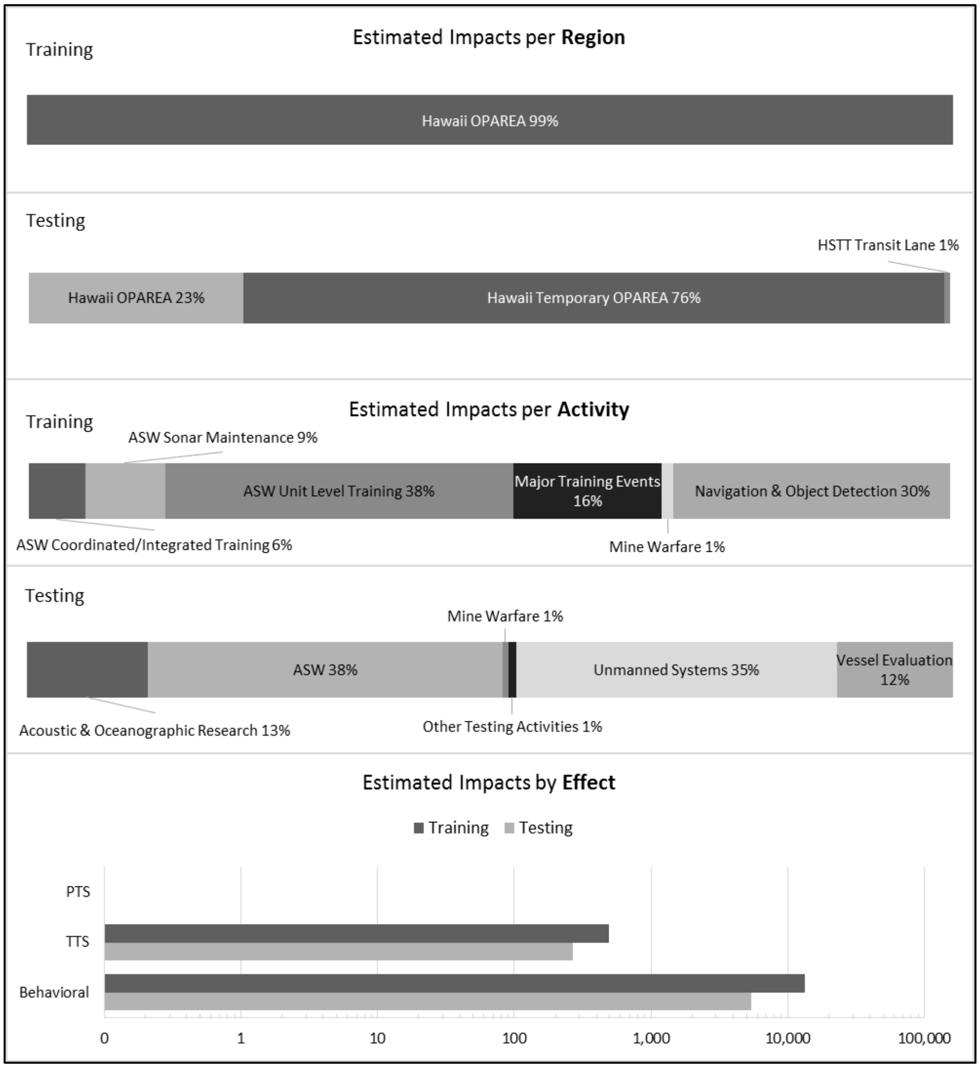
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Pantropical spotted dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-36 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-26).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, pantropical spotted dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pantropical spotted dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-36: Pantropical Spotted Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-26: Estimated Impacts on Individual Pantropical Spotted Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	2%	8%
Oahu	30%	4%
Hawaii Pelagic	49%	64%
Hawaii Island	19%	25%

6.4.2.3.3.13 Pygmy Killer Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Pygmy killer whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-37 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-27).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. However, sound from sonar or other transducers could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, pygmy killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pygmy killer whale natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of pygmy killer whales incidental to those activities.

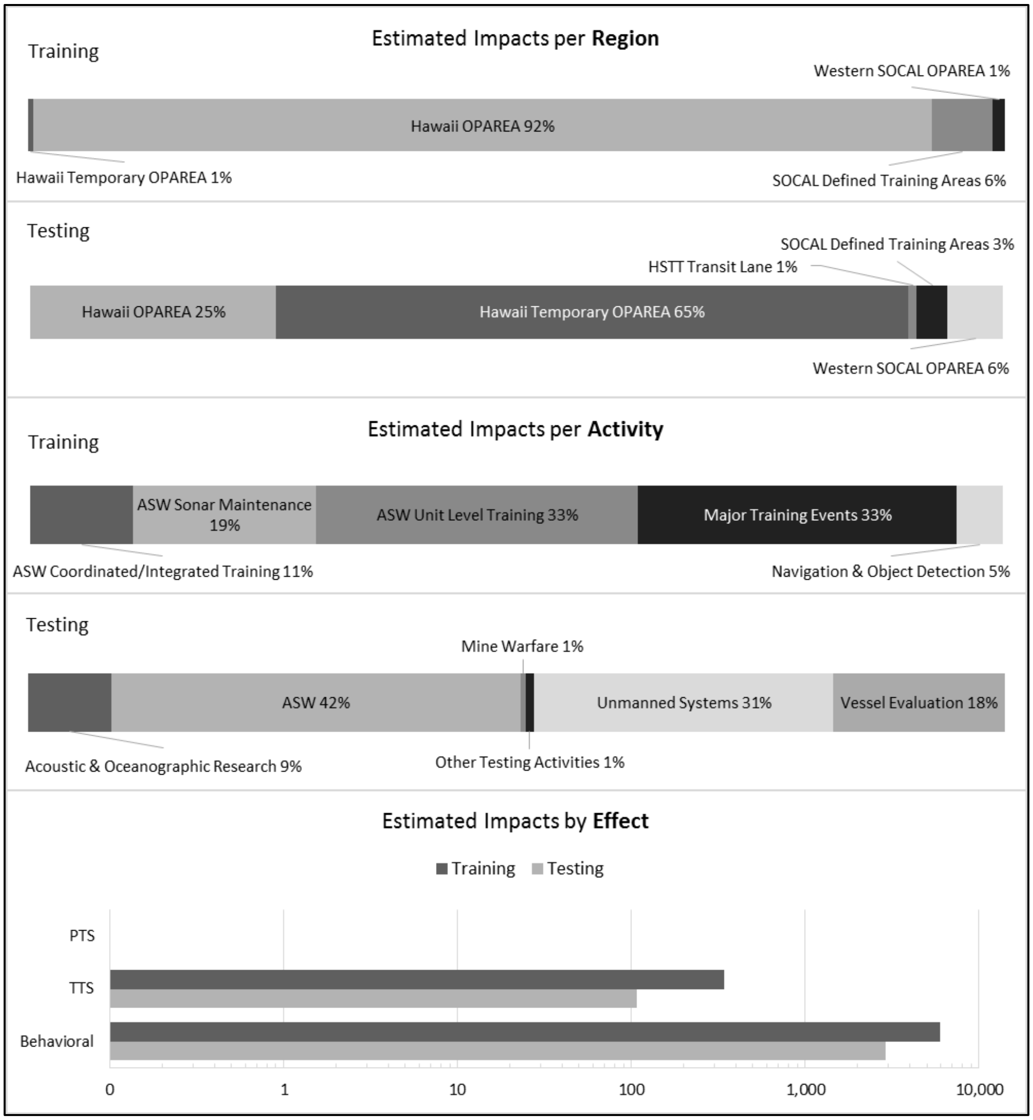
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Pygmy killer whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-37 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-27).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, pygmy killer whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pygmy killer whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of pygmy killer whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-37: Pygmy Killer Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-27: Estimated Impacts on Individual Pygmy Killer Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	93%	90%
Tropical	7%	10%

6.4.2.3.3.14 Risso's Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-38 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-28).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

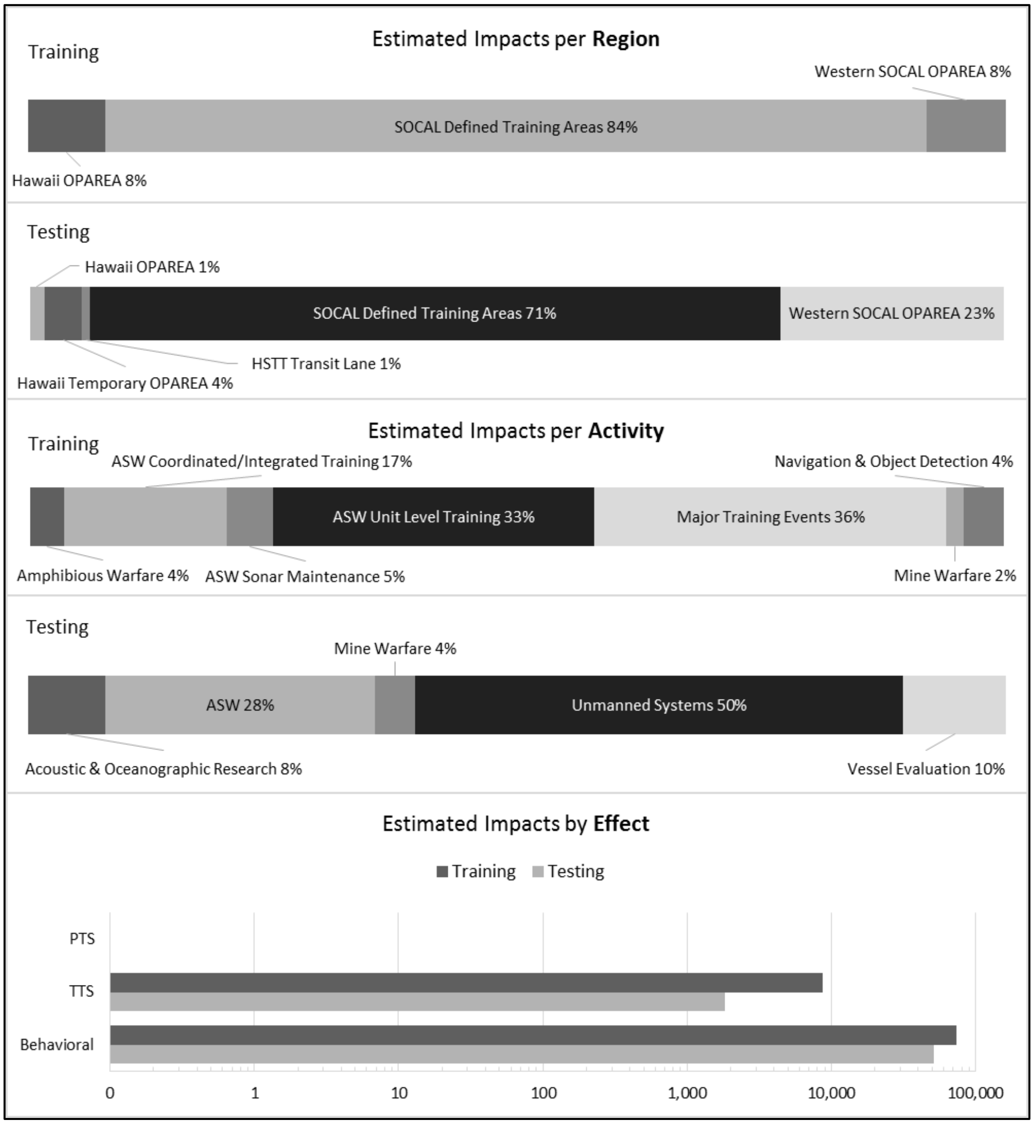
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Risso's incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Risso's dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-38 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-28).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Risso's dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-38: Risso's Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-28: Estimated Impacts on Individual Risso's Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	8%	5%
California, Oregon, & Washington	92%	95%

6.4.2.3.3.15 Rough-Toothed Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Rough-toothed dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-39 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from sonar or other transducers could still expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, rough-toothed dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to rough-toothed dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of rough-toothed dolphins incidental to those activities.

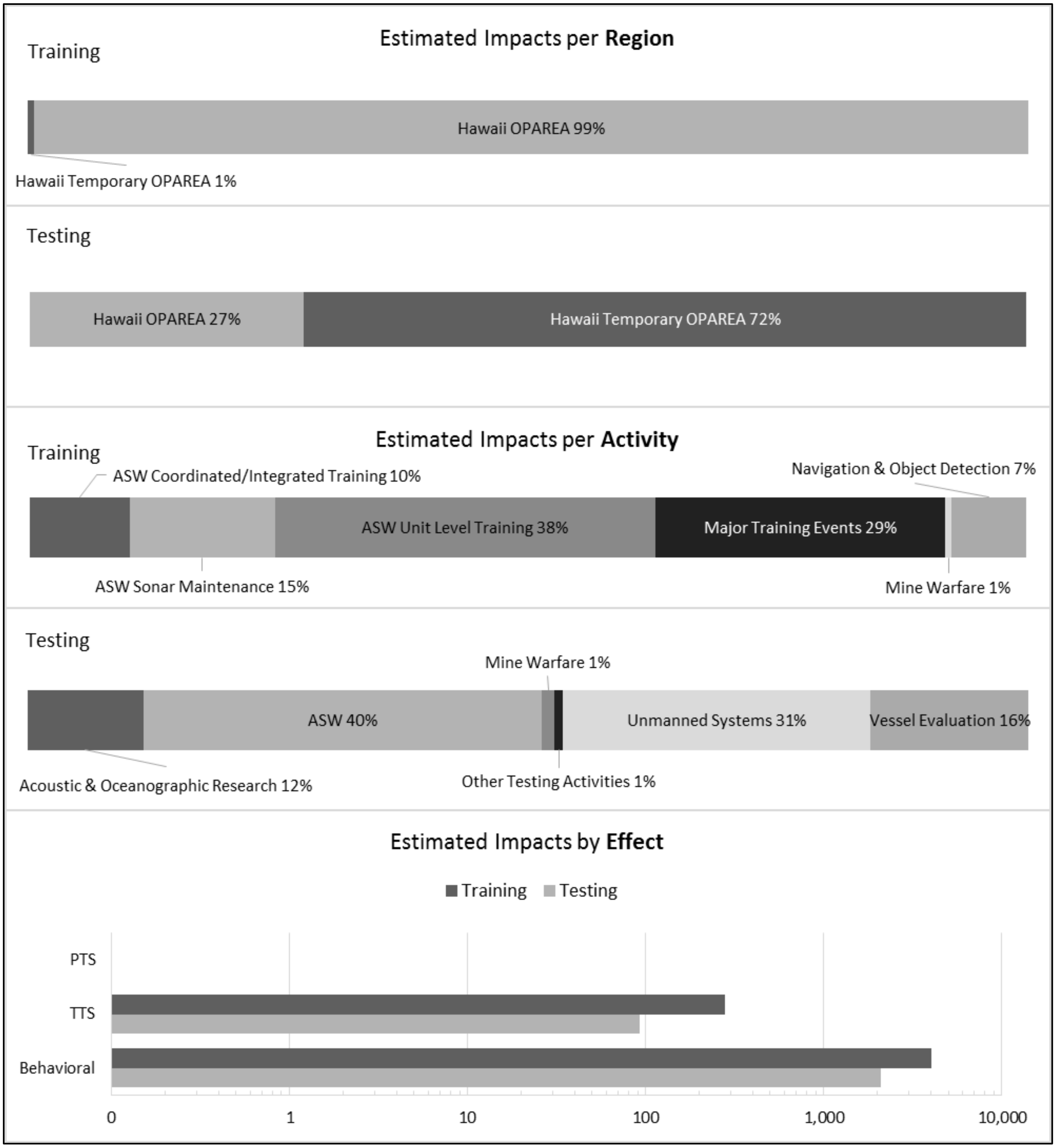
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Rough-toothed dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-39 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, sonar use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from sonar or other transducers could still expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, rough-toothed dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to rough-toothed dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of rough-toothed dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock.

Figure 6-39: Rough-Toothed Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.16 Short-Beaked Common Dolphin

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-40 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

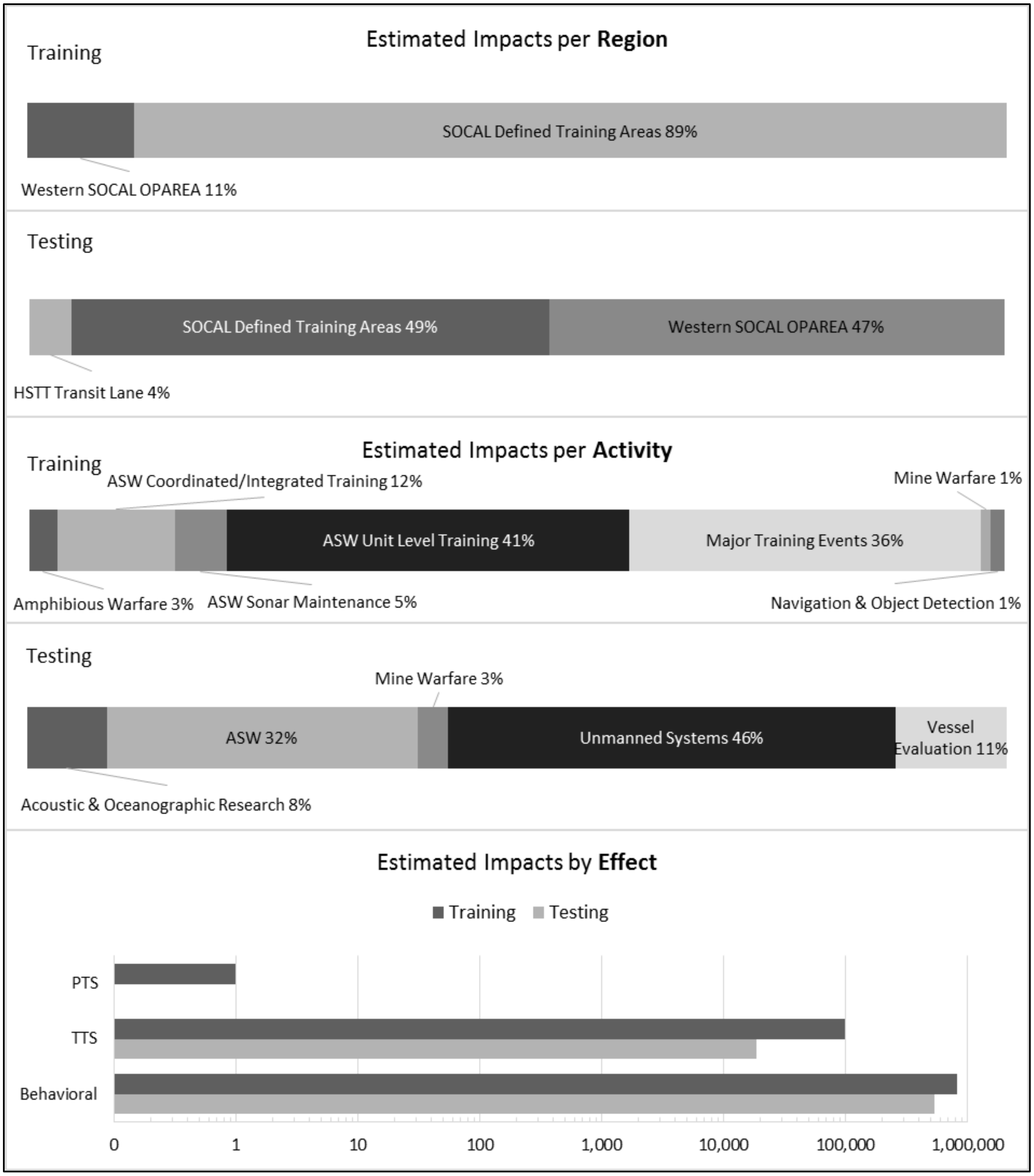
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of short-beaked common dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Short-beaked common dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-40 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of short-beaked common dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% California, Oregon, and Washington Stock.

Figure 6-40: Short-Beaked Common Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.3.17 Short-Finned Pilot Whales

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-41 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-29).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, short-finned pilot whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to short-finned pilot whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of short-finned pilot whales incidental to those activities.

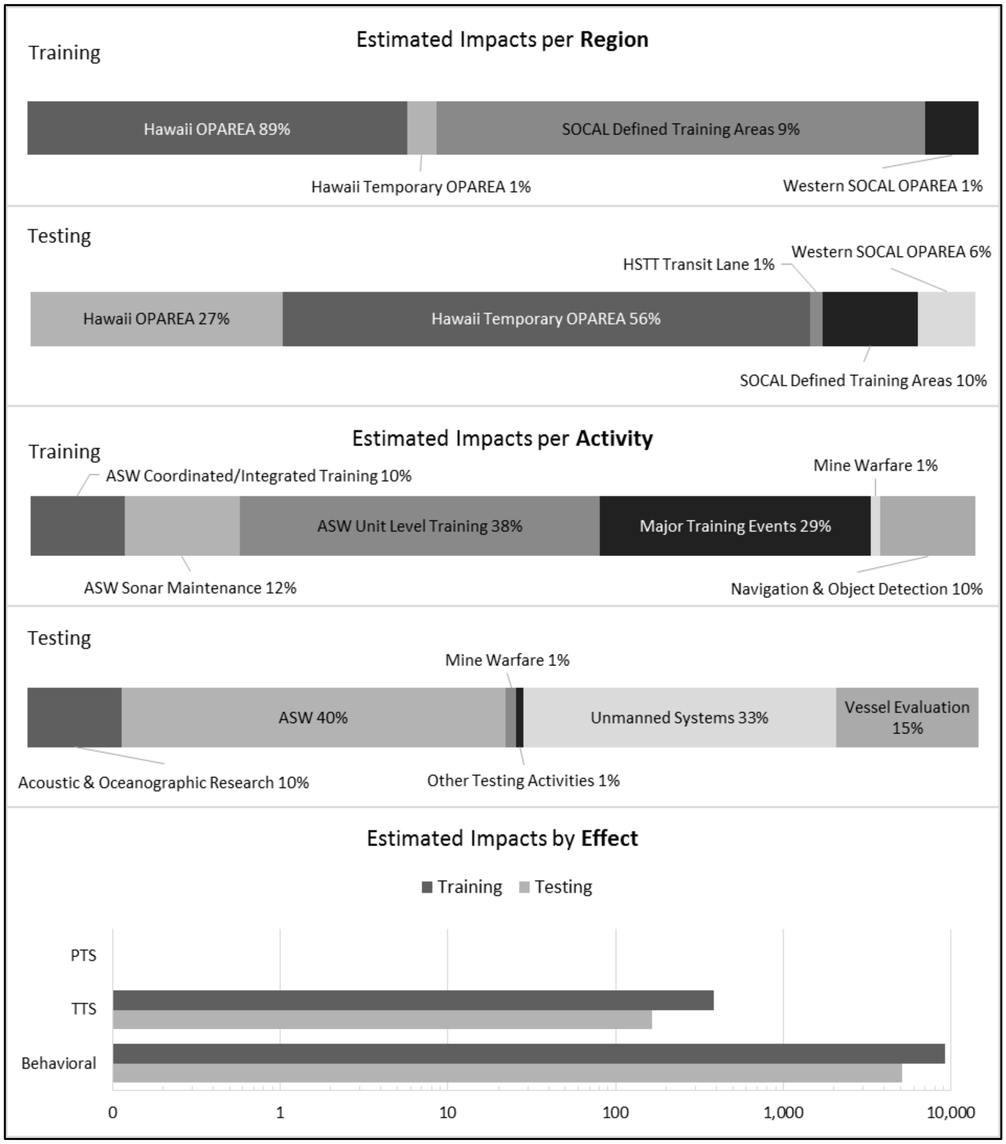
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Short-finned pilot whales may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, and TTS under the Proposed Action. See Figure 6-41 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-29).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015c) is within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, short-finned pilot whale reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to short-finned pilot whale natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population area identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of short-finned pilot whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-41: Short-Finned Pilot Whale Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-29: Estimated Impacts on Individual Short-Finned Pilot Whale Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	90%	82%
California, Oregon, & Washington	10%	18%

6.4.2.3.3.18 Spinner Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Spinner dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-42 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-30).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy training activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers, especially more intense activities such as anti-submarine warfare training or major training events. However, sound from sonar or other transducers could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, spinner dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to spinner dolphin natural behaviors or abandonment due to training with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of spinner dolphins incidental to those activities.

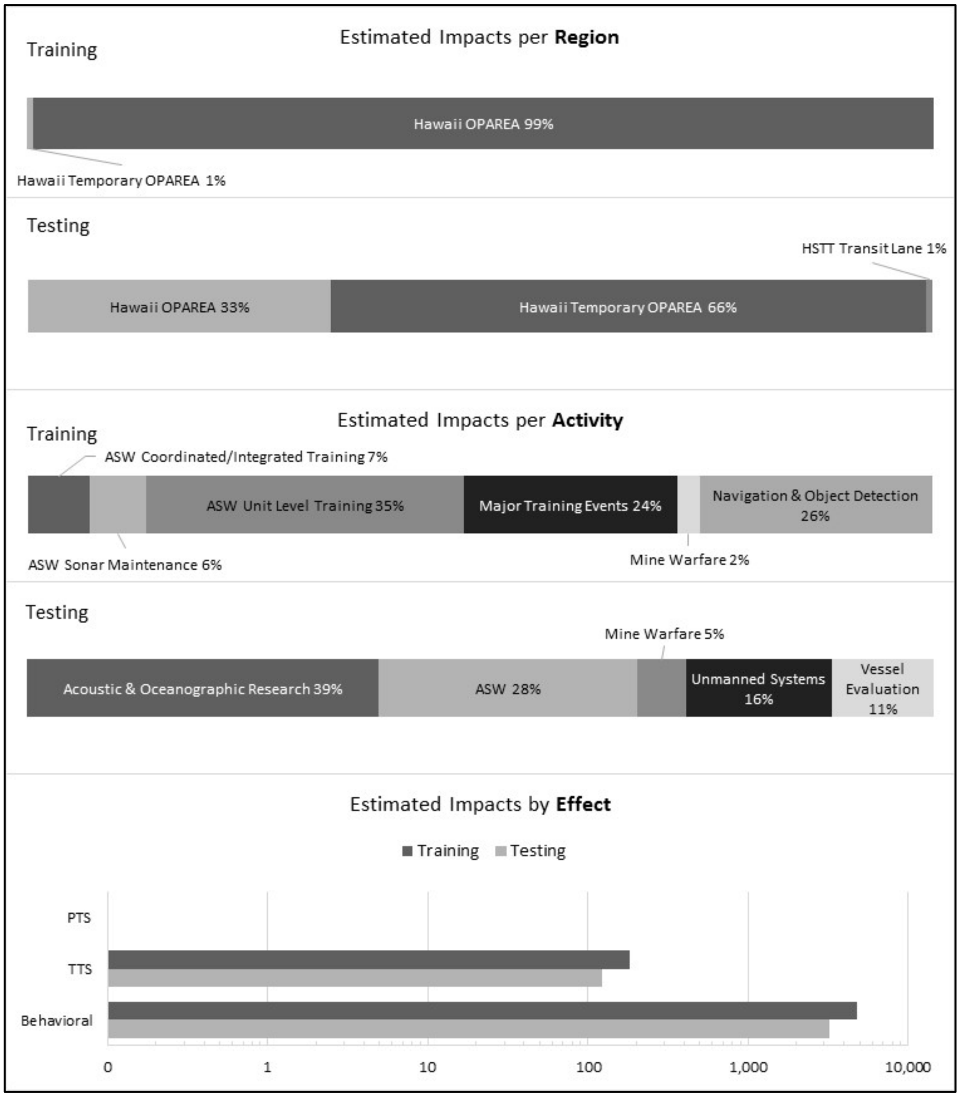
Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Spinner dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-42 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-30).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015c) are within the Hawaii Range Complex year-round. Navy testing activities that use sonar and other transducers could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve sonar or other transducers. However, sound from sonar or other transducers could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015c) and some impacts to behavior could occur. As discussed above, spinner dolphin reactions to sonar are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to spinner dolphin natural behaviors or abandonment due to testing with sonar and other transducers are unlikely to occur within the small and resident population areas identified by Baird et al. (2015c).

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of spinner dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.
ASW: Anti-Submarine Warfare; OPAREA: Operating Area; SOCAL: Southern California

Figure 6-42: Spinner Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-30: Estimated Impacts on Individual Spinner Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Kauai and Niihau	6%	43%
Hawaii Pelagic	62%	41%
Hawaii Island	2%	6%
Oahu and 4-Island	30%	10%

6.4.2.3.3.19 Striped Dolphins

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-43 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply to multiple stocks (see Table 6-31).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

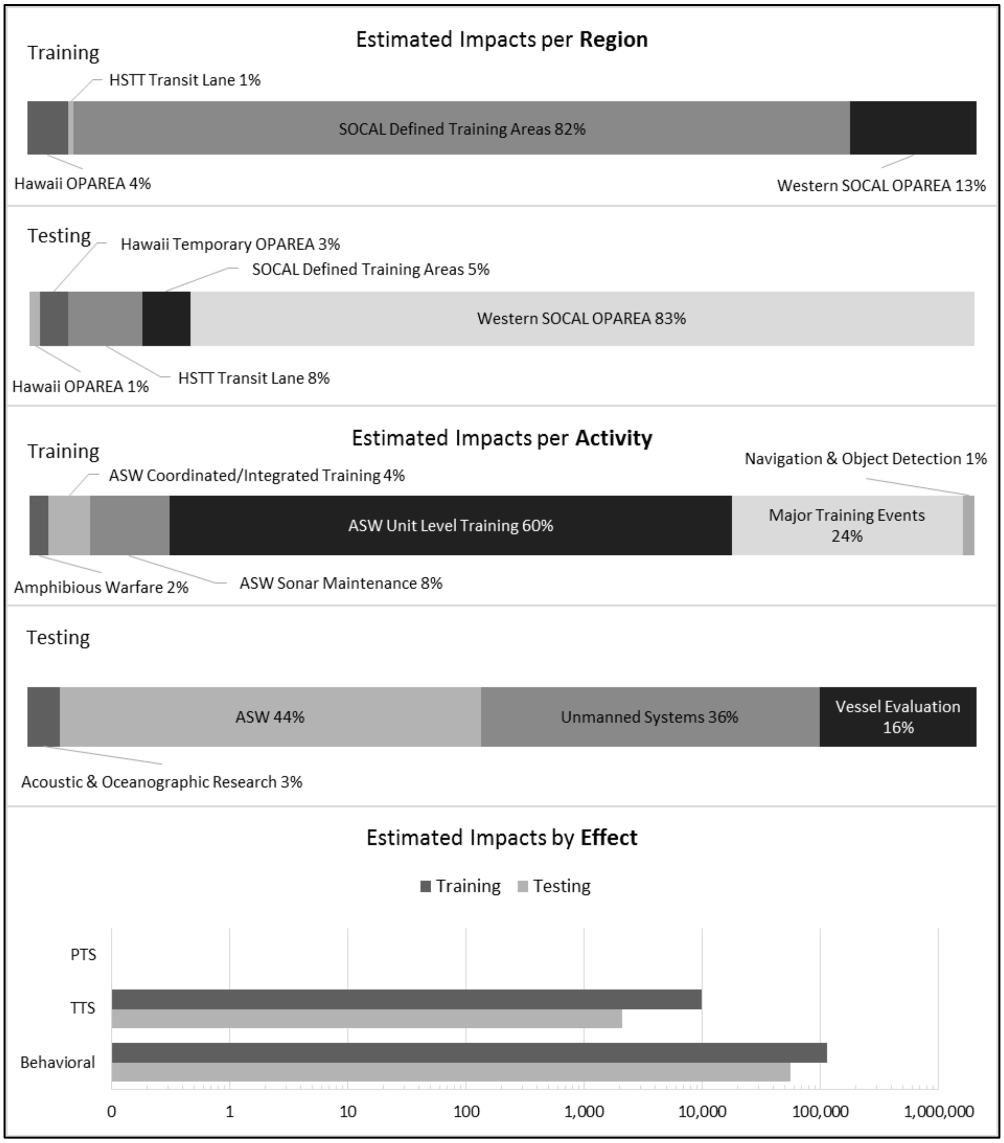
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of striped dolphins incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Striped dolphins may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-43 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers).

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of striped dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species.

Figure 6-43: Striped Dolphin Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Table 6-17: Estimated Impacts on Individual Striped Dolphin Stocks Within the Study Area per Year from Sonar and Other Transducers Used During Training and Testing

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	96%	96%
Hawaiian	4%	4%

6.4.2.3.3.20 Dall's Porpoises

Dall's porpoises are most likely to respond to exposures to sonar and other transducers with behavioral reactions or minor to moderate TTS that would fully recover quickly. The quantitative analysis predicts a few PTS per year; however, as discussed above, odontocetes would likely avoid sound levels that could cause higher levels of TTS (> 20 dB) or PTS. TTS and PTS thresholds for high-frequency cetaceans, including Dall's porpoises, are lower than for all other marine mammals, which leads to a higher number of estimated impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans). Dall's porpoises that do experience hearing loss (i.e., TTS or PTS) from sonar sounds may have a reduced ability to detect biologically important sounds until their hearing recovers. TTS would be recoverable and PTS would leave some residual hearing loss. During the period that a Dall's porpoise had hearing loss, biologically important sounds could be more difficult to detect or interpret. Odontocetes, including Dall's porpoises, use echolocation clicks to find and capture prey. These echolocation clicks are at frequencies above 100 kilohertz in Dall's porpoises; therefore, echolocation is unlikely to be affected by a threshold shift at lower frequencies and should not affect a Dall's porpoise's ability to locate prey or rate of feeding. The information available on harbor porpoise behavioral reactions to human disturbance (a closely related species) suggests that these species may be more sensitive and avoid human activity, and sound sources, to a longer range than most other odontocetes. This would make Dall's porpoises less susceptible to hearing loss; therefore, it is likely that the quantitative analysis over-predicted hearing loss impacts (i.e., TTS and PTS) in Dall's porpoises.

Research and observations on reactions to sound from sonar or other transducers are not available for Dall's porpoise. Another porpoise species, the harbor porpoise, is very sensitive to human-made sound and wary of human activity. It is assumed that Dall's porpoise is also more reactive than most other odontocetes and would avoid human-made sound and activities within a few kilometers. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Behavioral reactions from Dall's porpoises are more likely to be significant than in other species of odontocetes; however, most reactions estimated by the quantitative analysis are likely to be short-term and low to moderate severity.

Most estimated impacts are due to anti-submarine warfare activities, which could vary in duration and intensity. Anti-submarine warfare unit level events and sonar maintenance typically last for a matter of a few hours and involve a limited amount of sonar use so that significant responses would be less likely than with longer and more intense events. Coordinated unit level anti-submarine warfare events and major training events involve multiple sonar systems and can last for a period of days, making significant responses more likely. However, even a few minor to moderate TTS and behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual.

<u>Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities</u>

Dall's porpoises may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-44 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section

6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

A few behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small threshold shift due to exposure to sonar is unlikely to affect the hearing range that Dall's porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Dall's porpoises incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Dall's porpoises may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-44 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California, Oregon, and Washington stock.

A few behavioral reactions in an individual animal within a given year are unlikely to have any long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely and a small threshold shift due to exposure to sonar is unlikely to affect the hearing range that Dall's porpoise rely upon if it did occur. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Dall's porpoises incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% California, Oregon, and Washington Stock.

Figure 6-44: Dall's Porpoise Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.4 Pinnipeds

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals).

Pinnipeds may be exposed to sound from sonar and other transducers associated with training and testing activities throughout the year. Low- (less than 1 kHz), mid- (1–10 kHz), and high-frequency (10–100 kHz) sonars produce sounds that are likely to be within the audible range of pinnipeds (see Section 6.3, Marine Mammal Hearing and Vocalization). If a sound is within an animal's hearing range then behavioral reactions, physiological stress, masking and hearing loss are potential impacts that must be analyzed. If a marine mammal cannot hear a sound, then behavioral reactions, physiological stress, masking, or hearing loss could not occur. Impact ranges for pinnipeds are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers).

A few behavioral reactions in pinnipeds resulting from exposure to sonar could take place at distances of up to 10 km. Behavioral reactions, however, are much more likely within a kilometer or less of the sound source (see Section 6.4.1.5, Behavioral Reactions). As discussed above in Section 6.4.2.1.2 (Assessing the Severity of Behavioral Responses from Sonar), the quantitative analysis very likely overestimated the numbers of behavioral reactions due to the underlying nature of the data used to derive the behavioral response functions. Research shows that pinnipeds in the water are generally tolerant of human made sound and activity (see 6.4.1.5, Behavioral Reactions). If pinnipeds are exposed to sonar or other active acoustic sources, they may react in various ways, depending on their experience with the sound source and what activity they are engaged in at the time of the acoustic exposure. Pinnipeds may not react at all until the sound source is approaching within a few hundred meters and then may alert, ignore the stimulus, change their behaviors, or avoid the immediate area by swimming away or diving. Significant behavioral reactions would not be expected in most cases, and long-term consequences for individual pinnipeds from a single or several impacts per year are unlikely.

Behavioral research indicates that most pinnipeds probably avoid sound sources at levels that could cause higher levels of TTS (greater than 20 dB of TTS) and PTS. Recovery from TTS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days to fully recover, depending on the magnitude of the initial threshold shift. Most TTS, if it does actually occur, would be more likely to be minor to moderate (i.e., less than 20 dB of TTS directly after the exposure) and would recover within a matter of minutes to hours. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. During the short period that a pinniped had TTS, social calls from conspecifics could be more difficult to detect or interpret. Killer whales are a primary predator of pinnipeds. Some TTS could make killer whale calls more difficult to detect at further ranges until hearing recovers. Pinnipeds probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for pinnipeds with TTS to locate food for a short period before their hearing recovers. Because TTS would likely be minor to moderate (less than 20 dB of TTS), costs would be short-term and could be recovered. A single or even a few mild to moderate TTS per year are unlikely to have any long-term consequences for that individual.

Research and observations of masking in marine mammals are discussed in Section 6.4.1.4 (Masking). Many low- (less than 1 kHz), mid- (1–10 kHz), and high-frequency (10–100 kHz) sonars produce sounds that are likely to be within the hearing range of pinnipeds. Many anti-submarine warfare sonars and countermeasures use low- and mid-frequency ranges. Most low- and mid-frequency sonar signals (i.e.,

sounds) are limited in the temporal, frequency, and spatial domains. The duration of most individual sounds is short, lasting up to a few seconds each. Some systems operate with higher duty cycles or nearly continuously, but typically use lower power. Nevertheless, masking may be more prevalent at closer ranges to these high-duty cycle and continuous active sonar systems. Most anti-submarine warfare activities are geographically dispersed and last for only a few hours, often with intermittent sonar use even within this period. Most anti-submarine warfare sonars also have a narrow frequency band (typically less than one-third octave). These factors reduce the likelihood of sources causing significant masking in pinnipeds due to exposure to sonar used during anti-submarine warfare activities. Pinnipeds may experience some limited masking at closer ranges from high-frequency sonars and other transducers; however, the frequency band of the sonar is narrow, limiting the likelihood of masking. Sonars that employ high frequencies are typically used for mine hunting, navigation, and object detection (avoidance).

Potential costs to pinnipeds from masking are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source (i.e., sonar) is actively transmitting and the effect is over the moment the sound has ceased. Nevertheless, pinnipeds that do experience some masking for a short period from sonar or other transducers may have their ability to communicate with conspecifics reduced, especially at further ranges. Sounds from mid-frequency sonar could mask killer whale vocalizations making them more difficult to detect, especially at further ranges. Pinnipeds probably use sound and vibrations to find and capture prey underwater. Therefore, it could be more difficult for pinnipeds to locate food if masking is occurring. A single or even a few short periods of masking, if it were to occur, to an individual pinniped per year are unlikely to have any long-term consequences for that individual.

6.4.2.3.4.1 Guadalupe Fur Seals (Endangered Species Act-listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Guadalupe fur seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-45 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.2.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

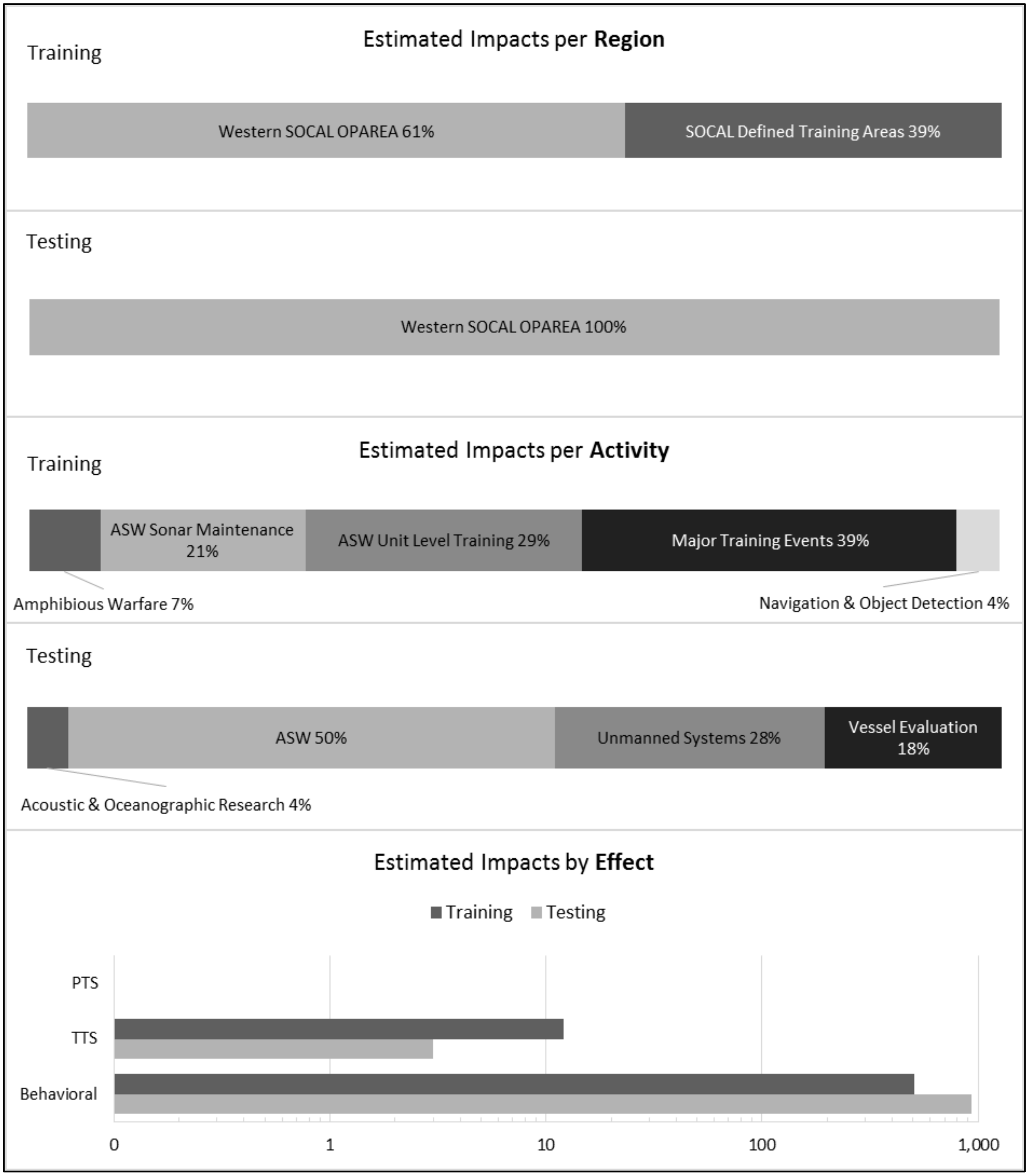
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Guadalupe fur seals incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Guadalupe fur seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-45 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Mexico stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Guadalupe fur seals incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Mexico Stock.

Figure 6-45: Guadalupe Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.4.2 Hawaiian Monk Seals (Endangered Species Act-listed)

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Hawaiian monk seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-46 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of Hawaiian monk seals incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Hawaiian monk seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-46 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the Hawaiian stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Hawaiian monk seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% Hawaiian Stock.

Figure 6-46: Hawaiian Monk Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.4.3 Harbor Seals

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Harbor seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-47 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of harbor seals incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Harbor seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-47 below or Section 5.1 for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of harbor seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% California Stock.

Figure 6-47: Harbor Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.4.4 Northern Elephant Seals

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-48 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, hearing loss beyond a minor TTS is unlikely. Nevertheless, PTS could have minor long-term consequences for individuals if it were to occur. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

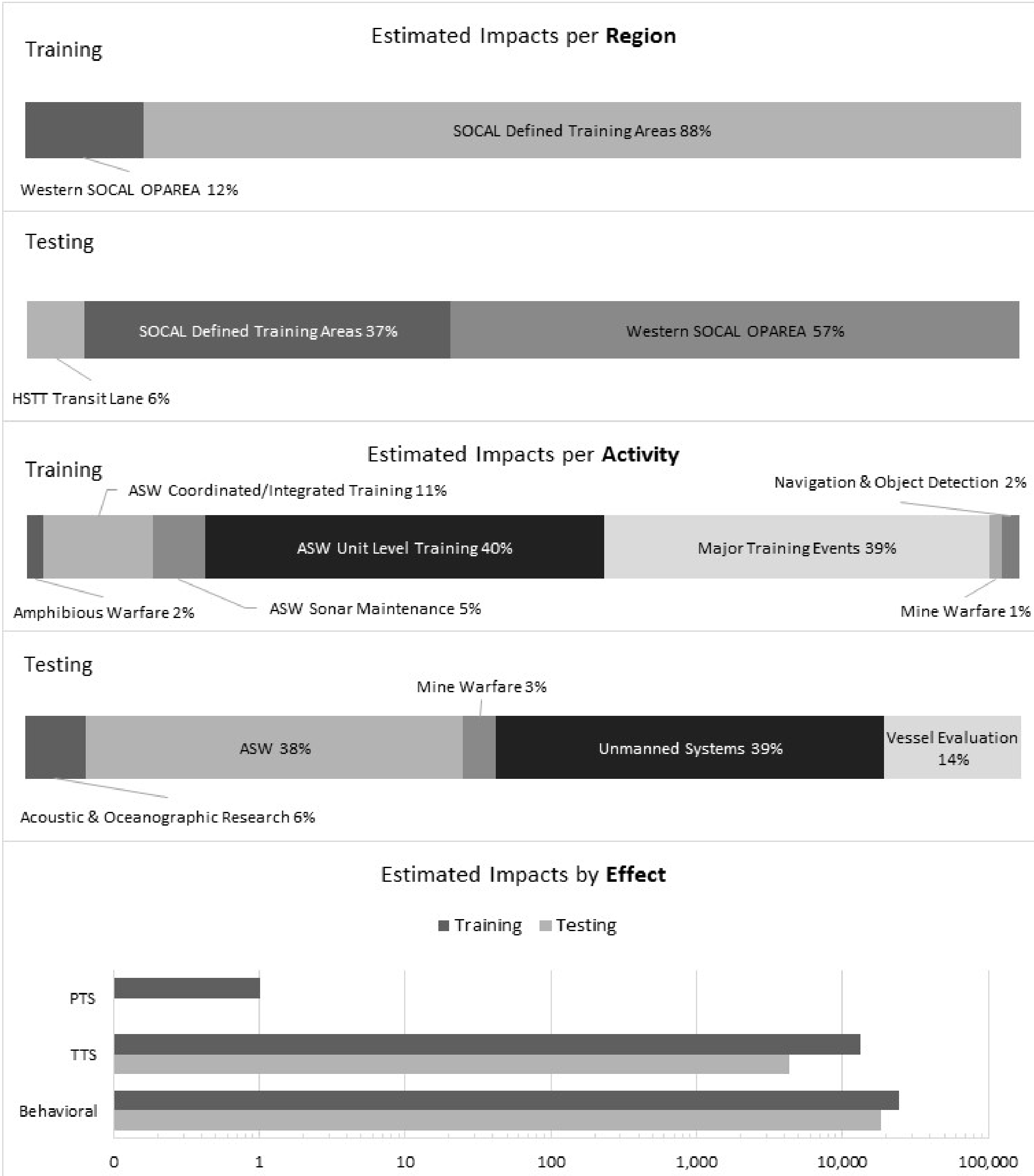
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of northern elephant seals incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Northern elephant seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-48 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of Northern elephant seals incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% California Stock.

Figure 6-48: Northern Elephant Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.2.3.4.5 California Sea Lions

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-49 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

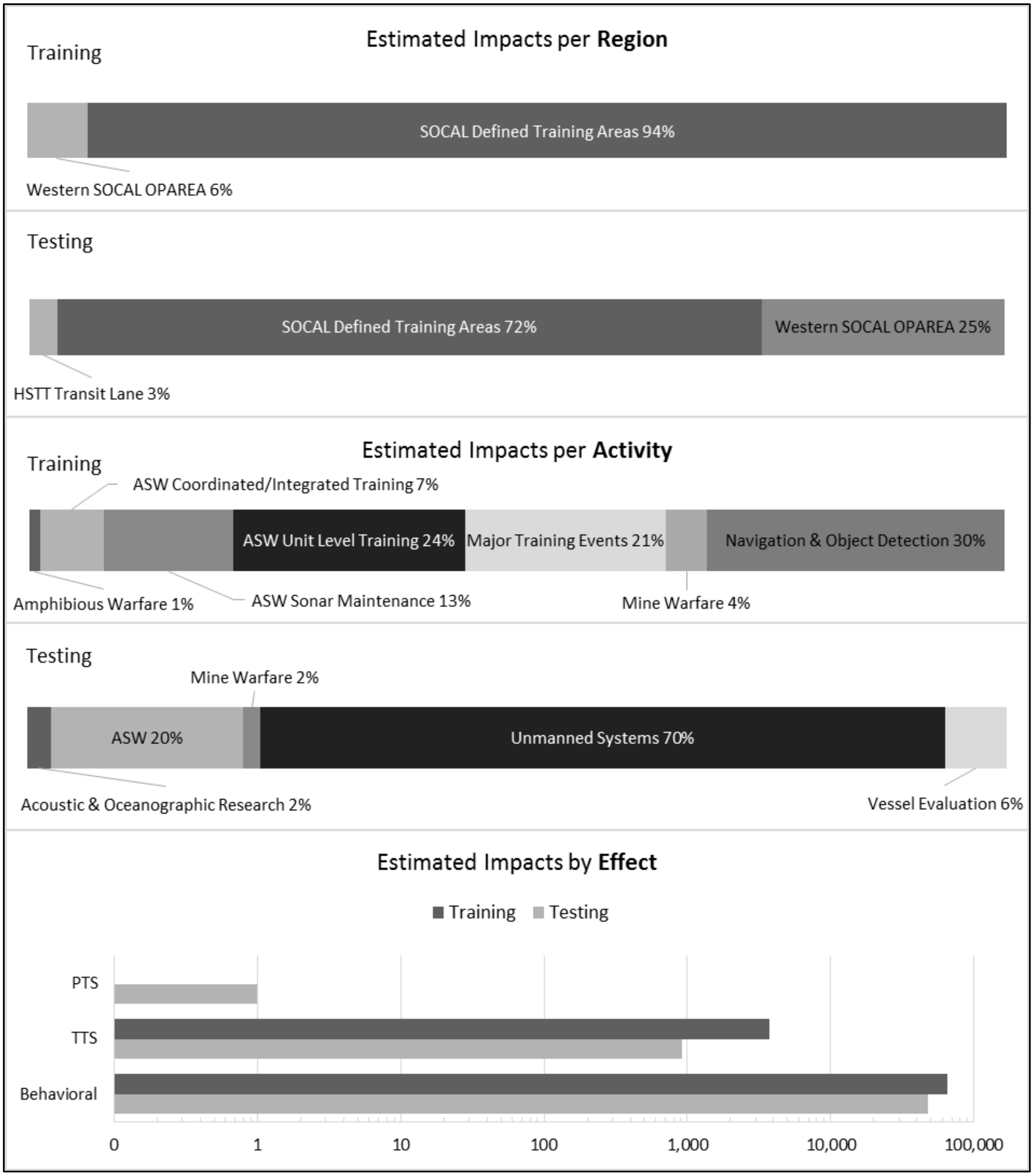
Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of California sea lions incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

California sea lions may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions, TTS, and PTS under the Proposed Action. See Figure 6-49 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the U.S. stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking California sea lions incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. 100% U.S. Stock.

Figure 6-49: California Sea Lion Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

Northern Fur Seals

Impacts from Sonar and Other Transducers under the Proposed Action for Training Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with training activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-50 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during training activities as described under the Proposed Action will result in the unintentional taking of northern fur seals incidental to those activities.

Impacts from Sonar and Other Transducers under the Proposed Action for Testing Activities

Northern fur seals may be exposed to sounds from sonar and other transducers associated with testing activities throughout the year. The quantitative analysis estimates behavioral reactions and TTS under the Proposed Action. See Figure 6-50 below or Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. Impact ranges for this species are discussed in Section 6.4.1.6.2 (Impact Ranges for Sonar and Other Transducers). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of sonar and other transducers during testing activities as described under the Proposed Action will result in the unintentional taking of northern fur seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. No PTS is estimated for this species. 100% California Stock.

Figure 6-50: Northern Fur Seal Impacts Estimated per Year from Sonar and Other Transducers Used During Training and Testing Under the Proposed Action

6.4.3 IMPACTS FROM AIR GUNS

Air guns use bursts of pressurized air to create broadband, impulsive sounds. Any use of air guns would typically be transient and temporary. Section 1.4.1.2 (Air Guns) provides additional details on the use and acoustic characteristics of the small air guns used in these activities.

6.4.3.1 Methods for Analyzing Impacts from Air Guns

The Navy performed a quantitative analysis to estimate the number times that marine mammals could be affected by air guns used during Navy testing activities. The Navy Acoustic Effects Model was used to produce initial estimates of the number of instances that animals may experience these effects. Inputs to the quantitative analysis included marine mammal density estimates; marine mammal depth distributions; oceanographic and environmental data; and criteria and thresholds for levels of potential impacts. A detailed explanation of this analysis is provided in the technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

6.4.3.1.1 Criteria and Thresholds used to Predict Impacts to Marine Mammals from Air Guns

See the technical report titled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III*) (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived.

6.4.3.1.1.1 Auditory Weighting Functions

Weighting functions are specific to each hearing group, but are the same across all noise types (e.g., sonar, air guns, and pile driving). See Auditory Weighting Functions under Section 6.4.2.1.1 (Methods for Analyzing Impacts from Sonars and Other Transducers) for information on the weighting thresholds used for analyzing sound from air guns.

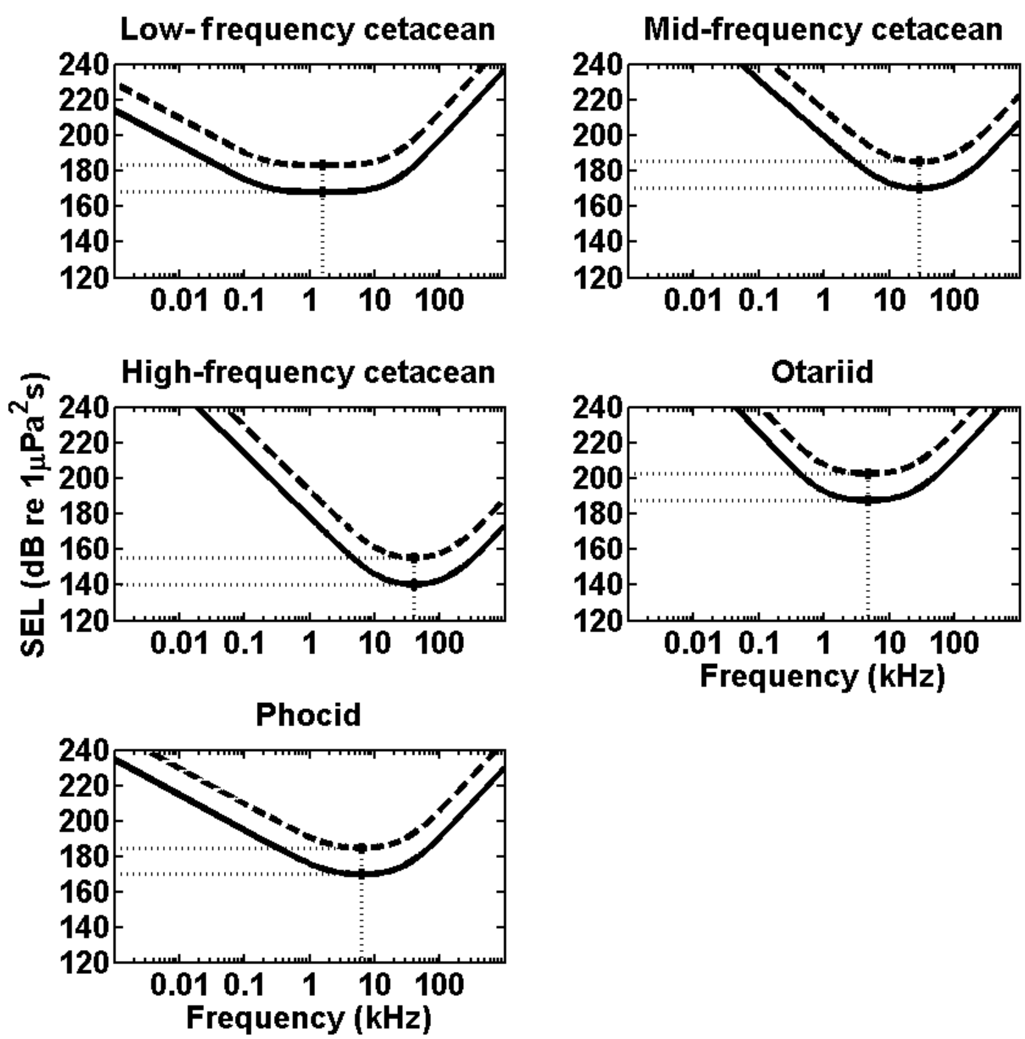
6.4.3.1.1.2 Hearing Loss from Air Guns

Criteria used to define threshold shifts from impulsive sound sources were derived from the two known studies designed to induce TTS in marine mammals from impulsive sources. Finneran et al. (2002) reported behaviorally-measured TTS of 6 and 7 dB in a beluga exposed to single impulses from a seismic water gun and Lucke et al. (2009) reported auditory evoked potential-measured TTS of 7 to 20 dB in a harbor porpoise exposed to single impulses from a seismic air gun. Since marine mammal PTS data from impulsive noise exposures do not exist, onset-PTS levels for all groups were estimated by adding 15 dB to the onset TTS SEL threshold for impulsive sources and 6 dB to the onset TTS peak SPL thresholds. This relationship was derived by Southall et al. (2007). These frequency dependent thresholds are depicted by the exposure functions for each group's range of best hearing (see Table 6-32 and Figure 6-51).

Table 6-32: Thresholds for Onset of TTS and PTS for Underwater Air Gun Sounds

Hearing Group	*Onset TTS*		*Onset PTS*	
	SEL dB re 1 µPa^{2}s (weighted)	*SPL peak dB re 1 µPa (unweighted)*	*SEL dB re 1 µPa^{2}s (weighted)*	*SPL peak dB re 1 µPa (unweighted)*
Low-frequency Cetaceans	168	213	183	219
Mid-frequency Cetaceans	170	224	185	230
High-frequency Cetaceans	140	196	155	202
Otariids in water	188	226	203	232
Phocid seals in water	170	212	185	218

PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift



The solid curve is the exposure function for TTS onset and the large dashed curve is the exposure function for PTS onset. Small dashed lines and asterisks indicate the SEL threshold for TTS and PTS onset in the frequency range of best hearing.

Figure 6-51: Temporary Threshold Shift and Permanent Threshold Shift Exposure Functions for Air Guns

6.4.3.1.1.3 Behavioral Responses from Air Guns

The existing NMFS Level B disturbance threshold of 160 dB re 1 µPa (rms) is applied to the unique sounds generated by air guns. The root mean square calculation for air guns is based on the duration defined by 90 percent of the cumulative energy in the impulse.

6.4.3.1.2 Marine Mammal Density

A quantitative analysis of impacts on a species requires data on their abundance and distribution in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. To characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. The Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal species present within the Study Area (U.S. Department of the Navy, 2017e).

The models used to estimate density for a specific species or stock in a specific area, as described in in the HSTT Density Technical Report, should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

6.4.3.1.3 The Navy's Acoustic Effects Model

The Navy's quantitative analysis estimates the sound and energy received by marine mammals distributed in the area around planned Navy activities involving air guns. See the technical report titled Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles (U.S. Department of the Navy, 2017d) for additional details.

6.4.3.2 Impact Ranges for Air Guns

Table 6-33 and Table 6-34 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for air guns for 1 and 10 pulses, respectively. Ranges are specific to the HSTT Study Area and also specific to each marine mammal hearing group, dependent upon their criteria and the specific locations where animals from the hearing groups and the air gun activities could overlap.

Table 6-33: Range to Effects from Air Guns for 1 Pulse

Range to Effects for Air Guns[1] for 10 pulses (m)					
Hearing Group	**PTS (SEL)**	**PTS (Peak SPL)**	**TTS (SEL)**	**TTS (Peak SPL)**	**Behavioral[2]**
High-Frequency Cetacean	0 (0–0)	18 (15–25)	1 (0–2)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	3 (3–4)	2 (2–3)	27 (23–35)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2—3)	0 (0–0)	5 (4—8)	668 (290—1,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. PTS and TTS values depict the range produced by SEL and Peak SPL (as noted) hearing threshold criteria levels. [2]Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

Table 6-34: Range to Effects from Air Guns for 10 Pulses

Range to Effects for Air Guns[1] for 100 pulses (m)					
Hearing Group	**PTS (SEL)**	**PTS (Peak SPL)**	**TTS (SEL)**	**TTS (Peak SPL)**	**Behavioral[2]**
High-Frequency Cetacean	0 (0–0)	18 (15–25)	3 (0–9)	33 (25–80)	702 (290–1,525)
Low-Frequency Cetacean	15 (12–20)	2 (2–3)	86 (70–140)	5 (4–7)	651 (200–1,525)
Mid-Frequency Cetacean	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	689 (290–1,525)
Otariidae	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	590 (290–1,525)
Phocids	0 (0–0)	2 (2–3)	4 (3—5)	5 (4—8)	668 (290—1,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. PTS and TTS values depict the range produced by SEL and Peak SPL (as noted) hearing threshold criteria levels. [2]Behavioral values depict the ranges produced by RMS hearing threshold criteria levels.

6.4.3.3 Impacts from Air Guns under the Proposed Action

6.4.3.3.1 Impacts from Air Guns for Training Activities

Training activities do not include the use of air guns.

6.4.3.3.2 Impacts from Air Guns for Testing Activities

Characteristics of air guns and the number of times they would be operated during testing under the Proposed Action are described in Section 1.4.1 (Acoustic Stressors). Activities using air guns would be conducted as described in Section 1.5 (Proposed Action) and Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS. Under the Proposed Action, small air guns (12–60 $in.^3$) would be fired at off-shore locations in both the Southern California and Hawaii Range Complexes.

Single, small air guns lack the peak pressures that could cause non-auditory injury [see Finneran et al. (2015); also Section 6.5.1.1 (Injury) in Explosive Stressors]. Potential impacts could include PTS, TTS, behavioral reactions, physiological stress and masking (see Figure 6 52 and Section 5.1, Incidental Take Request from Acoustic and Explosive Sources, for tabular results).

Research and observations (see Section 6.4.1.5, Behavioral Reactions) show that if marine mammals are exposed to sounds from air guns they could potentially react with short-term behavioral reactions and physiological stress. It is important to point out that many observations of marine mammal reactions to air guns are from oil and gas exploration activities that use large air gun arrays and operate continuously for multiple weeks to cover large areas of the ocean. Navy activities, in contrast, only use single air guns over a much shorter period over a limited area. Reactions to single air guns, which are used in a limited fashion, are less likely to occur or rise to the same level of severity. Cetaceans (both mysticetes and odontocetes) may react in a variety of ways to impulsive sounds, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all. Research shows that pinnipeds may be the least sensitive taxonomic group to most noise sources, and are likely to respond to loud impulsive sound sources only at close ranges by startling or ceasing foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience mild TTS before exhibiting a behavioral response (Southall et al., 2007). Marine mammals disturbed while engaged in activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from air gun activities is short-term and intermittent, it is unlikely that a marine mammal would be exposed to noise that would result in any more than a short-term and mild to moderate behavioral responses.

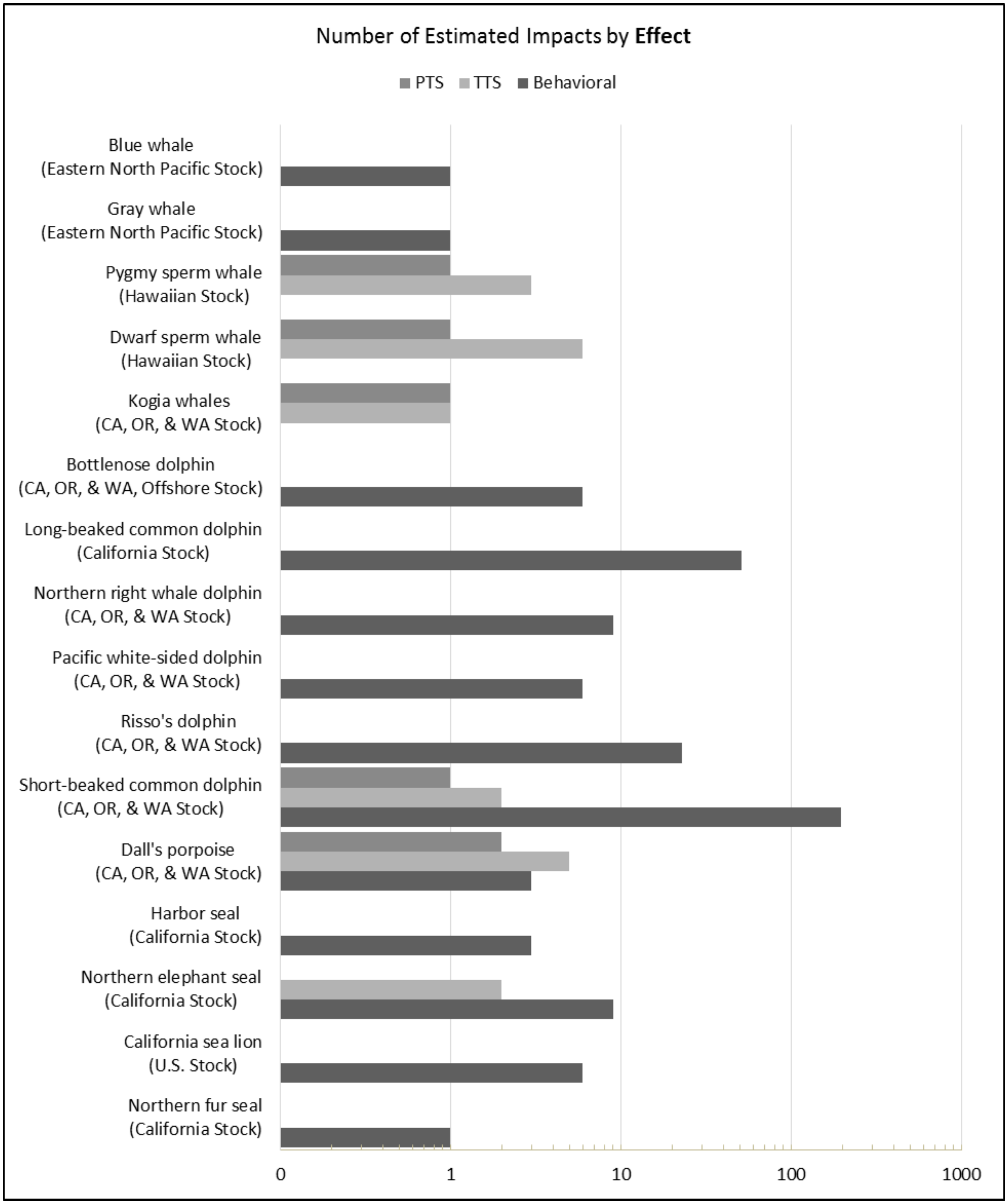


Figure 6-52: Estimated Annual Impacts from Air Gun Use

The sound from air gun shots is broadband, but they have a very short duration, lasting for less than a second each, and are used intermittently. This limits the potential for any significant masking in marine mammals. Potential costs to marine mammals from masking, if it were to occur, are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source is actively producing sound and the effect is over the moment the sound has ceased. Given these factors, significant masking is unlikely to occur in marine mammals due to exposure to sound from air guns.

As discussed above, estimated impacts to marine mammals from air gun sounds associated with testing activities are likely to consist of a small number of behavioral responses, TTS and PTS. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. Because these activities only occur a few times per year, have a small footprint of potential impacts with no impacts estimated for most species, and mitigation measures would be conducted as discussed in Chapter 11 (Mitigation Measures), long-term consequences for any marine mammal species or stocks would be unlikely.

The reproduction area for humpback whales identified by Baird et al. (2015c) overlaps the Hawaii Range Complex within the HSTT Study Area. No impacts to humpback whales from exposure to air gun sounds are estimated by the quantitative analysis. This identified humpback whale reproduction area is mostly in shallow, near-shore waters where the Navy does not typically conduct testing activities. Impacts, if they did occur, would most likely be short-term, minor behavioral responses. Therefore, significant impacts to humpback whale reproductive behaviors from air gun sounds associated with testing activities are unlikely to occur within the reproduction area identified by Baird et al. (2015c).

Twenty areas for small and resident populations of various species of odontocetes identified by Baird et al. (2015) are located within the Hawaii Range Complex year-round. These identified areas cover 11 species of odontocetes: dwarf sperm whales (1 area), Blainville’s beaked whales (1 area), Cuvier’s beaked whales (1 area), pygmy killer whales (1 area), short-finned pilot whales (1 area), melon-headed whales (1 area), false killer whales (1 area), pantropical spotted dolphins (3 areas), spinner dolphins (5 areas), rough-toothed dolphins (1 area), and common bottlenose dolphins (4 areas). The quantitative analysis did estimate a few TTS and a single PTS for dwarf sperm whales, and a few behavioral reactions for bottlenose dolphins.

Even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. PTS, if it were to occur, would leave some residual hearing loss after recovery from the initial threshold shift. Minor PTS in an individual could have no to minor long-term consequences for individuals. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks. Behavioral reactions, if they did occur, would most likely be short-term, minor behavioral responses. Significant impacts to natural behaviors or abandonment of any of the 20 small and resident population areas identified by Baird et al. (2015c) for 11 species of odontocetes would not be anticipated due to exposure to air gun sounds associated with testing activities.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Range Complex within the Study Area. However, these feeding areas make up a very small portion of the Study Area. The quantitative analysis

estimates a single blue whale may behaviorally respond to an air gun exposure. It is unlikely that air gun noise would affect the feeding behaviors of blue whales on their identified feeding areas beyond short-term, minor behavioral responses. Therefore, significant impacts to blue whale feeding behaviors from air gun sounds associated with testing activities are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015a).

Four migration areas for gray whales identified by Calambokidis et al. (2015a) along the U.S. West Coast overlap the Southern California Range Complex within the Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific date range depending on what portion of the northbound or southbound migration it is meant to cover. Navy testing activities with air guns could occur year-round within the Study Area. The quantitative analysis estimates a single gray whale may behaviorally respond to an air gun exposure. Behavioral responses, if they did occur, would most likely be sort-term and minor. Therefore, significant impacts to gray whale migration behaviors from air gun sounds associated with testing activities are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015a).

Pursuant to the MMPA, the use of air guns during testing activities as described under the Proposed Action will result in the unintentional taking of blue whales, gray whales, Dwarf and pygmy sperm whales, kogia whales, bottlenose dolphins, long-beaked dolphins, Northern right whale dolphins, Pacific white-sided dolphins, Risso’s dolphins, short-beaked common dolphins, Dall’s porpoise, harbor seals, Northern elephant seals, California sea lions, and Northern fur seals incidental to those activities.

6.4.4 IMPACTS FROM PILE DRIVING

Marine mammals could be exposed to sounds from impact and vibratory pile driving during the construction and removal phases of the elevated causeway described in Section 1.5 (Proposed Action). The training involves the use of an impact hammer to drive the 24-inch (in.) steel piles into the sediment followed by a vibratory hammer to remove the piles that support the causeway structure. Impact pile driving operations to install the piles averages about 20 days, and removal of the piles at the end of the exercise takes approximately 10 days. Section 1.4.1.3 (Pile Driving) provides additional details on pile driving and noise levels measured from similar operations.

6.4.4.1 Methods for Analyzing Impacts from Pile Driving

The Navy performed a quantitative analysis to estimate the number of marine mammals that could be impacted by pile driving used during Navy training activities. Inputs to the quantitative analysis included marine mammal density estimates and criteria for levels of potential effects.

6.4.4.1.1 Criteria and Thresholds used to Estimate Impacts to Marine Mammals from Pile Driving

See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017c) for detailed information on how the criteria and thresholds were derived.

6.4.4.1.1.1 Auditory Weighting Functions

Weighting functions are specific to each hearing group, but are the same across all noise types (e.g., sonar, air guns, and pile driving). See Auditory Weighting Functions under Section 6.4.2.1.1, Methods for Analyzing Impacts from Sonars and Other Transducers, for information on the weighting functions used for analyzing sound from pile driving.

6.4.4.1.1.2 Hearing Loss from Pile Driving

Because vibratory pile removal produces continuous, non-impulsive noise, the criteria used to assess the onset of TTS and PTS due to exposure to sonars are used to assess auditory impacts to marine mammals (see Hearing Loss from Sonar and Other Transducers in Section 6.4.2.1.1, Methods for Analyzing Impacts from Sonars and Other Transducers).

Because impact pile driving produces impulsive noise, the criteria used to assess the onset of TTS and PTS are identical to those used for air guns (see Hearing Loss from Air Guns in Section 6.4.3.1, (Methods for Analyzing Impacts from Air Guns).

6.4.4.1.1.3 Behavioral Responses from Pile Driving

Existing NMFS risk criteria are applied to estimate behavioral effects from impact and vibratory pile driving (Table 6-35).

Table 6-35: Pile Driving Level B Thresholds Used in this Analysis to Predict Behavioral Responses from Marine Mammals

Pile Driving Criteria (Sound Pressure Level, dB re 1 µPa) Level B Disturbance Threshold	
Underwater Vibratory	***Underwater Impact***
120 dB rms	160 dB rms

Note: Root mean square calculation for impact pile driving is based on the duration defined by 90 percent of the cumulative energy in the impulse. Root mean square for vibratory pile driving is calculated based on a representative time series long enough to capture the variation in levels, usually on the order of a few seconds.
dB: decibel; dB re 1 µPa: decibel referenced to 1 micro pascal; rms: root mean square

6.4.4.1.2 Marine Mammal Density

A quantitative analysis of impacts on a species requires data on their abundance and distribution in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. To characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. The Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the Navy Marine Species Density Database includes seasonal density values for every marine mammal species present within the Study Area (U.S. Department of the Navy, 2017e).

The models used to estimate density for a specific species or stock in a specific area, as described in in the HSTT Density Technical Report, should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

6.4.4.1.3 Modeling of Pile Driving Noise

Underwater noise effects from pile driving and vibratory pile extraction were modeled using actual measures of impact pile driving and vibratory removal during construction of an elevated causeway (Illingworth and Rodkin, 2015, 2016). A conservative estimate of spreading loss of sound in shallow coastal waters (i.e., transmission loss = 16.5*Log10[radius]) was applied based on spreading loss observed in actual measurements. Inputs used in the model are provided in Section 1.4.1.3 (Pile Driving), including source levels; the number of strikes required to drive a pile and the duration of vibratory removal per pile; the number of piles driven or removed per day; and the number of days of pile driving and removal.

The exposures predicted from elevated causeway assessment rely on the assumption that marine mammals are uniformly distributed within the ocean waters adjacent the proposed event locations. In fact, animal presence in the surf zone and nearshore waters of the Silver Strand Training Complex and Marine Corps Base Camp Pendleton (within a few kilometers) is known to be patchy and infrequent with the exception of a few coastal species (e.g., common dolphins, bottlenose dolphins, harbor seals, and sea lions).

6.4.4.2 Impact Ranges for Pile Driving

Table 6-36 and Table 6-6-37 present the approximate ranges in meters to PTS, TTS, and potential behavioral reactions for impact pile driving and vibratory pile removal, respectively.

Table 6-36: Average Ranges to Effects from Impact Pile Driving

Hearing Group	*PTS (m)*	*TTS (m)*	*Behavioral (m)*
Low-frequency Cetaceans	65	529	870
Mid-frequency Cetaceans	2	16	870
High-frequency Cetaceans	65	529	870
Phocids	19	151	870
Otariids	2	12	870

PTS: permanent threshold shift; TTS: temporary threshold shift

Table 6-37: Average Ranges to Effect from Vibratory Pile Extraction

Hearing Group	*PTS (m)*	*TTS (m)*	*Behavioral (m)*
Low-frequency Cetaceans	0	3	376
Mid-frequency Cetaceans	0	4	376
High-frequency Cetaceans	7	116	376
Phocids	0	2	376
Otariids	0	0	376

PTS: permanent threshold shift; TTS: temporary threshold shift

6.4.4.3 Impacts from Pile Driving under the Proposed Action

6.4.4.3.1 Impacts from Pile Driving for Training Activities

Characteristics of pile driving and the number of times pile driving for the elevated causeway system would occur during training under the Proposed Action are described in Section 1.4.1 (Acoustic Stressors). Activities with pile driving would be conducted as described in Section 1.5 (Proposed Action) and Appendix A (Navy Activity Descriptions) of the HSTT Draft EIS/OEIS. This activity would take place nearshore and within the surf zone, up to two times per year, once at Silver Strand Training Complex and once at Marine Corps Base Camp Pendleton. These coastal areas tend to have high ambient noise levels due to natural and anthropogenic sources and typically have limited numbers of sensitive marine mammal species present.

Sounds from the impact hammer are impulsive, broadband and dominated by lower frequencies. The impulses are within the hearing range of marine mammals. Sounds produced from a vibratory hammer are similar in frequency range as that of the impact hammer, except the levels are much lower than for the impact hammer and the sound is continuous while operating. Potential impacts to marine mammals due to exposure to pile driving sounds include hearing loss, behavioral reactions, physiological stress, and masking, although the quantitative analysis (see Figure 6-53 and Section 5.1, Incidental Take Request from Acoustic and Explosive Sources for tabular results) estimates only behavioral reactions in a few species due to exposure to pile driving activities associated with the construction and removal of the elevated causeway.

Behavioral responses due to impact pile driving could occur out to a distance of approximately 1 km. The vibratory hammer produces a much lower source level than the impact hammer, especially when extracting piles from sandy, nearshore ground; therefore, the potential for reactions in marine mammals due to vibratory pile extraction are unlikely. Short-term behavioral reactions to impact pile driving are much more likely.

Research and observations (see 6.4.1.5, Behavioral Reactions) show that if marine mammals are exposed to sounds from pile driving or extraction they could potentially react with short-term behavioral reactions and physiological stress. Mysticetes may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all. Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise sources is located directly on their migration route, although training associated with the elevated causeway is conducted nearshore, outside of any migratory paths for mysticetes. Odontocete reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Research shows that pinnipeds may be the least sensitive taxonomic group to most noise sources, and are likely to respond to loud impulsive sound sources only at close ranges by startling or ceasing foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience mild TTS before exhibiting a behavioral response (Southall et al., 2007). Marine mammals disturbed while engaged in activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from pile driving activities is short-term, intermittent, and occurs in a nearshore environment with high levels of ambient noise, it is unlikely that a marine mammal would be exposed to noise that would result in any more than a short-term and mild-to-moderate behavioral responses. Additionally, mitigation measures discussed in Chapter 11 (Mitigation Measures) would be conducted to further reduce any potential for impacts.

The vibratory hammer produces sounds that are broadband and continuous, creating the potential to cause some masking in marine mammals, but the effect would be temporary because extracting a pile only takes about 6 minutes, with a pause between each pile. Due to the low source level of vibratory pile extraction, the zone for potential masking would only extend a few hundred meters from where the hammer is operating. For impact pile driving, the average rate of 35 strikes per minute has the potential to result in some masking in marine mammals. The effect would be temporary as each pile only takes about 15 minutes to drive, with a pause of up to an hour before the next pile is driven. Furthermore, the Elevated Causeway System is constructed in shallow, nearshore areas where ambient noise levels are already typically high. Potential costs to marine mammals from masking, if it were to occur, are similar to those discussed above for mild to moderate levels of TTS, with the primary difference being that the effects of masking are only present when the sound source is actively producing sound and the effect is over the moment the sound has ceased. Given these factors, significant masking is unlikely to occur in marine mammals due to exposure to sound from impact pile driving or vibratory pile extraction.

As discussed above, estimated impacts to marine mammals from pile driving and extraction associated with the construction and removal of the elevated causeway consist of primarily short-term behavioral reactions. Because these activities only occur a few weeks per year and have a small footprint of potential impacts, the same animal would not be expected to be impacted more than a few times in a given year due to exposure pile driving sound. A single behavioral reaction in an individual animal within a given year is very unlikely to have any long-term consequences for that individual. Considering these factors, and the low number of overall estimated impacts, long-term consequences for marine mammal species or stocks would be unlikely.

Four migration areas for gray whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap the Southern California Portion of the HSTT Study Area. The identified areas are active altogether during the months of July through March, although each individual area has its own specific

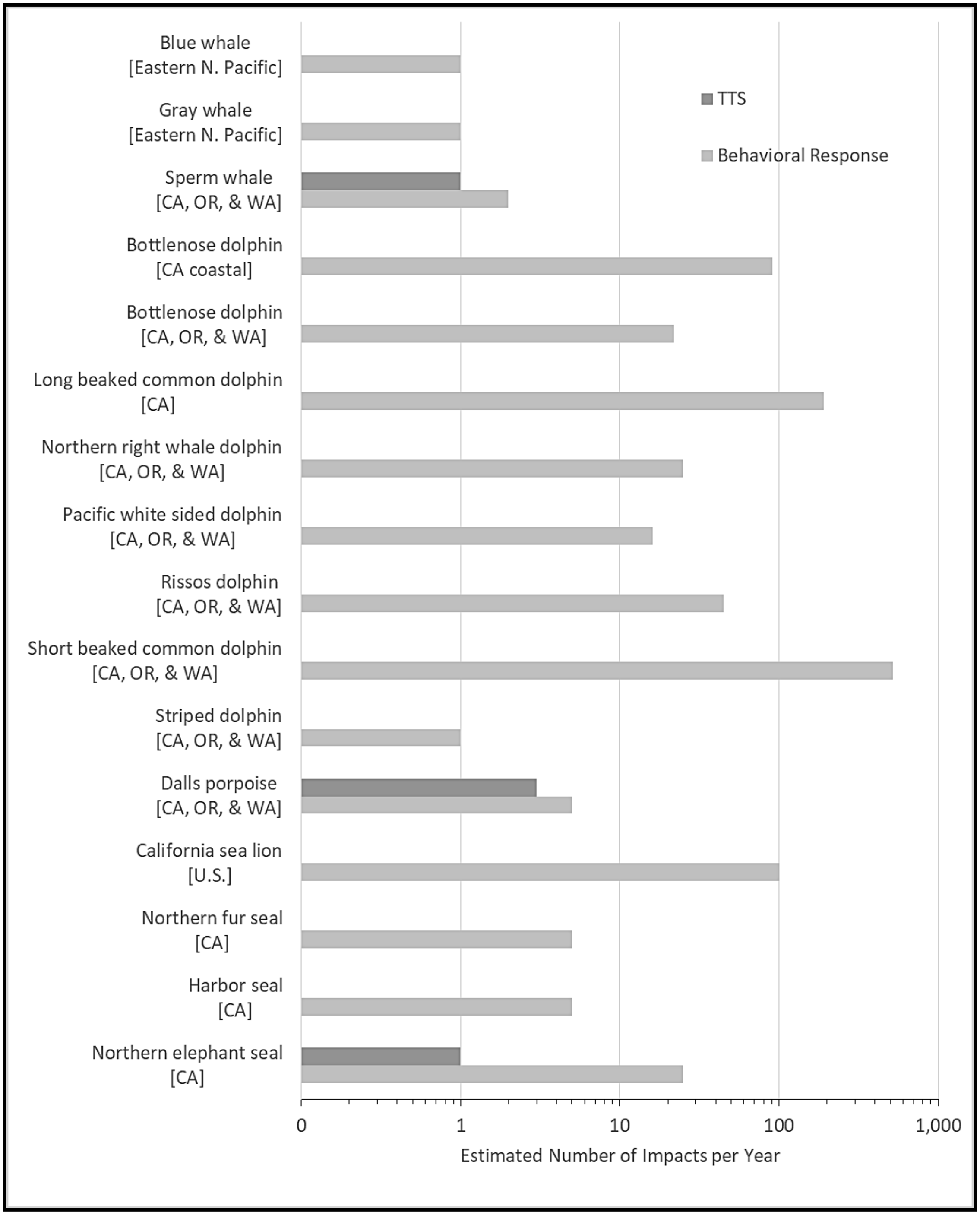
date range depending on what portion of the northbound or southbound migration it is meant to cover. Construction and removal of the elevated causeway could occur up to twotimes per year during any time of year at Silver Strand Training Complex or MCB Camp Pendleton in the nearshore environment, which is within a designated gray whale migration area. As discussed above, gray whales may pause their migration or re-route if a sound source is located directly on their path, however pile driving and extraction is performed within the surf zone and in the nearshore environment, outside of the migratory corridor. Gray whale reactions, if they did occur would most likely be short-term and mild. Therefore, significant impacts to gray whale migration behaviors are unlikely to occur within the gray whale migration areas identified by Calambokidis et al. (2015) because of pile driving and extraction associated with the construction and removal of the elevated causeway.

Four of nine feeding areas for blue whales identified by Calambokidis et al. (2015) along the U.S. West Coast overlap (2 wholly and 2 partially) the Southern California Portion of the HSTT Study Area in July through October. Construction and removal of the elevated causeway could occur up to two times per year during any time of year at Silver Strand Training Complex or MCB Camp Pendleton in the nearshore environment, which is near a designated blue whale feeding area. Blue whales within this designated area could be exposed to distant sounds from pile driving and extraction training activities. As discussed above, mysticete reactions to impulsive sound would most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away and when the animals are engaged in important biological behaviors such as feeding. Therefore, significant impacts to blue whale feeding behaviors are unlikely to occur within the blue whale feeding areas identified by Calambokidis et al. (2015) because of pile driving and extraction associated with the construction and removal of the elevated causeway.

Pursuant to the MMPA, the pile driving and removal during training activities as described under the Proposed Action will result in the unintentional taking of blue whales, gray whales,sperm whales, bottlenose dolphins, long-beaked common dolphins, northern right whale dolphins, Pacific white sided dolphins, Risso’s dolphins, short-beaked common dolphin, striped dolphins, short-beaked common dolphins, Dall’s porpoises, harbor seals, Northern elephant seals, California sea lions and Northern fur seals incidental to those activities.

6.4.4.3.2 Impacts from Pile Driving for Testing Activities

Testing activities do not include pile driving.



No impacts are anticipated for any other species within the HSTT Study Area. See Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) for tabular results. No PTS is exstimated for pile driving activities. This activity would not occur within the Hawaii Range Complex.

Figure 6-53: Estimated Annual Impacts (Assuming Two Events per Year) from Pile Driving and Extraction Associated with the Construction and Removal of the Elevated Causeway

6.5 EXPLOSIVE STRESSORS

6.5.1 BACKGROUND

6.5.1.1 Injury

Injury refers to the direct effects on the tissues or organs of an animal due to exposure to pressure waves. Injury in marine mammals can be caused directly by exposure to explosions. The Conceptual Framework for Assessing Effects from Sound-Producing Activities (see Section 6.2) provides additional information on injury and the framework used to analyze this potential impact.

6.5.1.1.1 Injury due to Explosives

Explosive injury to marine mammals would consist of primary blast injury, which refers to those injuries that result from the compression of a body exposed to a blast wave and is usually observed as barotrauma of gas-containing structures (e.g., lung and gut) and structural damage to the auditory system (Greaves et al., 1943; Office of the Surgeon General, 1991; Richmond et al., 1973). The near instantaneous high magnitude pressure change near an explosion can injure an animal where tissue material properties significantly differ from the surrounding environment, such as around air-filled cavities such as in the lungs or gastrointestinal tract. Large pressure changes at tissue-air interfaces in the lungs and gastrointestinal tract may cause tissue rupture, resulting in a range of injuries depending on degree of exposure. The lungs are typically the first site to show any damage, while the solid organs (e.g., liver, spleen, and kidney) are more resistant to blast injury (Clark & Ward, 1943). Recoverable injuries would include slight lung injury, such as capillary interstitial bleeding, and contusions to the gastrointestinal tract. More severe injuries, such as tissue lacerations, major hemorrhage, organ rupture, or air in the chest cavity (pneumothorax), would significantly reduce fitness and likely cause death in the wild. Rupture of the lung may also introduce air into the vascular system, producing air emboli that can cause a stroke or heart attack by restricting oxygen delivery to critical organs.

If an animal is exposed to an explosive blast underwater, the likelihood of injury depends on the charge size, the geometry of the exposure (distance to the charge, depth of the animal and the charge), and the size of the animal. In general, an animal would be less susceptible to injury near the water surface because the pressure wave reflected from the water surface would interfere with the direct path pressure wave, reducing positive pressure exposure. Susceptibility would increase with depth, until normal lung collapse (due to increasing hydrostatic pressure) and increasing ambient pressures again reduce susceptibility. See Appendix D (Acoustic and Explosive Concepts) of the HSTT Draft EIS/OEIS for an overview of explosive propagation and an explanation of explosive effects on gas cavities.

The only known occurrence of mortality or injury to a marine mammal due to a Navy training or testing event involving explosives occurred in March 2011 in nearshore waters off San Diego, California, at the Silver Strand Training Complex. This area has been used for underwater demolitions training for at least three decades without prior known incident. On this occasion, however, a group of approximately 100-150 long-beaked common dolphins entered the mitigation zone surrounding an area where a time-delayed firing device had been initiated on an explosive with a net explosive weight (NEW) of 8.76 pounds (lbs) (3.97 kilograms [kg]) placed at a depth of 48 ft. (14.6 m). Approximately 1 minute after detonation, three animals were observed dead at the surface. The Navy recovered those animals and transferred them to the local stranding network for necropsy. A fourth animal was discovered stranded and dead 42 NM to the north of the detonation 3 days later. It is unknown exactly how close those four

animals were to the detonation. Upon necropsy, all four animals were found to have sustained typical mammalian primary blast injuries (Danil & St. Ledger, 2011).

Relatively little is known about auditory system trauma in marine mammals resulting from explosive exposure, although it is assumed that auditory structures would be vulnerable to blast injuries. Auditory trauma was found in two humpback whales that died following the detonation of a 5,000 kg explosive used off Newfoundland during demolition of an offshore oil rig platform (Ketten et al., 1993), but the proximity of the whales to the detonation was unknown. Eardrum rupture was examined in submerged terrestrial mammals exposed to underwater explosions (Richmond et al., 1973; Yelverton et al., 1973); however, results may not be applicable to the anatomical adaptations for underwater hearing in marine mammals. In this discussion, primary blast injury to auditory tissues is considered gross structural tissue damage distinct from threshold shift or other auditory effects (see Section 6.5.1.2, Hearing Loss and Auditory Injury).

Controlled tests with a variety of lab animals (mice, rats, dogs, pigs, sheep and other species) are the best data sources on actual injury to mammals due to underwater exposure to explosions. In the early 1970s, the Lovelace Foundation for Medical Education and Research conducted a series of tests in an artificial pond at Kirtland Air Force Base, New Mexico to determine the effects of underwater explosions on mammals, with the goal of determining safe ranges for human divers. The resulting data were summarized in two reports (Richmond et al., 1973; Yelverton et al., 1973). Specific physiological observations for each test animal are documented in Richmond et al. (1973). Gas-containing internal organs, such as lungs and intestines, were the principle damage sites in submerged terrestrial mammals; this is consistent with earlier studies of mammal exposures to underwater explosions in which lungs were consistently the first areas to show damage, with less consistent damage observed in the gastrointestinal tract (Clark & Ward, 1943; Greaves et al., 1943). Results from all of these tests suggest two explosive metrics are predictive of explosive injury: peak pressure and impulse.

6.5.1.1.1.1 Impulse as a Predictor of Explosive Injury

In the Lovelace studies, acoustic impulse was found to be the metric most related to degree of injury, and size of an animal's gas-containing cavities was thought to play a role in blast injury susceptibility. The lungs of most marine mammals are similar in proportion to overall body size as those of terrestrial mammals, so the magnitude of lung damage in the tests may approximate the magnitude of injury to marine mammals when scaled for body size. Within the marine mammals, mysticetes and deeper divers (e.g., Kogiidae, Physeteridae, Ziphiidae) tend to have lung to body size ratios that are smaller and more similar to terrestrial animal ratios than the shallow diving odontocetes (e.g., Phocoenidae, Delphinidae) and pinnipeds (Fahlman et al., 2014a; Piscitelli et al., 2010). The use of test data with smaller lung to body ratios to set injury thresholds may result in a more conservative estimate of potential for damaging effects (i.e., lower thresholds) for animals with larger lung to body ratios.

For these shallow exposures of small terrestrial mammals (masses ranging from 3.4 to 50 kg) to underwater detonations, Richmond et al. (1973) reported that no blast injuries were observed when exposures were less than 6 pounds per square inch per millisecond (psi-ms) (40 Pa-s), no instances of slight lung hemorrhage occurred below 20 psi-ms (140 Pa-s), and instances of no lung damage were observed in some exposures at higher levels up to 40 psi-ms (280 Pa-s). An impulse of 34 psi-ms (230 Pa-s) resulted in about 50 percent incidence of slight lung hemorrhage. About half of the animals had gastrointestinal tract contusions (with slight ulceration, i.e., some perforation of the mucosal layer)

at exposures of 25-27 psi-ms (170-190 Pa-s). Lung injuries were found to be slightly more prevalent than GI tract injuries for the same exposure.

The Lovelace subject animals were exposed near the water surface; therefore, depth effects were not discernible in this data set. In addition, this data set included only small terrestrial animals, whereas marine mammals may be several orders of magnitude larger and have respiratory structures adapted for the high pressures experienced at depth. Goertner (1982) examined how lung cavity size would affect susceptibility to blast injury by considering both marine mammal size and depth in a bubble oscillation model of the lung. Animal depth relates to injury susceptibility in two ways: injury is related to the relative increase in explosive pressure over hydrostatic pressure, and lung collapse with depth reduces the potential for air cavity oscillatory damage. The period over which an impulse must be delivered to cause damage is assumed to be related to the natural oscillation period of an animal's lung, which depends on lung size.

Because gas-containing organs are more vulnerable to primary blast injury, adaptations for diving that allow for collapse of lung tissues with depth may make animals less vulnerable to lung injury with depth. Adaptations for diving include a flexible thoracic cavity, distensible veins that can fill space as air compresses, elastic lung tissue, and resilient tracheas with interlocking cartilaginous rings that provide strength and flexibility (Ridgway, 1972). Older literature suggested complete lung collapse depths at approximately 70 m for dolphins (Ridgway & Howard, 1979) and 20–50 m for phocid seals (Falke et al., 1985; Kooyman et al., 1972). Follow-on work by Kooyman and Sinnett (1982), in which pulmonary shunting was studied in harbor seals and sea lions, suggested that complete lung collapse for these species would be about 170 m and about 180 m, respectively. More recently, evidence in sea lions suggests that complete collapse might not occur until depths as great as 225 m; although the depth of collapse and depth of the dive are related, sea lions can affect the depth of lung collapse by varying the amount of air inhaled on a dive (McDonald & Ponganis, 2012). This is an important consideration for all divers who can modulate lung volume and gas exchange prior to diving via the degree of inhalation and during diving via exhalation (Fahlman et al., 2009); indeed, there are noted differences in pre-dive respiratory behavior with some marine mammals exhibiting pre-dive exhalation to reduce the lung volume [e.g., phocid seals (Kooyman et al., 1973)].

6.5.1.1.1.2 Peak Pressure as a Predictor of Explosive Injury

High instantaneous peak pressures can cause damaging tissue distortion. Goertner (1982) suggested a peak overpressure gastrointestinal tract injury criterion because the size of gas bubbles in the GI tract are variable, and their oscillation period could be short relative to primary blast wave exposure duration. The potential for gastrointestinal tract injury, therefore, may not be adequately modeled by the single oscillation bubble methodology used to estimate lung injury due to impulse. Like impulse, however, high instantaneous pressures may damage many parts of the body, but damage to the gastrointestinal tract is used as an indicator of any peak pressure-induced injury due to its vulnerability.

Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 psi (237 dB re 1 µPa peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974). Around 200 psi, the shock wave felt like a blow to the head and chest. Data from the Lovelace Foundation experiments show instances of gastrointestinal tract contusions after exposures up to 1147 psi peak pressure, while exposures of up to 588 psi peak pressure resulted in many instances of no observed gastrointestinal tract effects. The

lowest exposure for which slight contusions to the gastrointestinal tract were reported was 237 dB re 1 µPa peak. As a vulnerable gas-containing organ, the gastrointestinal tract is vulnerable to both high peak pressure and high impulse, which may vary to differing extents due to blast exposure conditions (i.e., animal depth, distance from the charge). This likely explains the range of effects seen at similar peak pressure exposure levels and shows the utility of considering both peak pressure and impulse when analyzing the potential for injury due to explosives.

6.5.1.2 Hearing Loss and Auditory Injury

Exposure to intense sound may result in noise-induced hearing loss that persists after cessation of the noise exposure. Hearing loss may be temporary or permanent, depending on factors such as the exposure frequency, received SPL, temporal pattern, and duration. The frequencies affected by hearing loss may vary depending on the exposure frequency, with frequencies at and above the exposure frequency most strongly affected. The amount of hearing loss may range from slight to profound, depending on the ability of the individual to hear at the affected frequencies. The Conceptual Framework for Assessing Effects from Sound-Producing Activities (see Section 6.2) provides additional information on hearing loss and the framework used to analyze this potential impact.

Hearing loss has only been studied in a few species of marine mammals, although hearing studies with terrestrial mammals are also informative. There are no direct measurements of hearing loss in marine mammals due to exposure to explosive sources. The sound resulting from an explosive detonation is considered an impulsive sound and shares important qualities (i.e., short duration and fast rise time) with other impulsive sounds such as those produced by air guns. General research findings regarding TTS and PTS in marine mammals as well as findings specific to exposure to other impulsive sound sources are discussed in Hearing Loss and Auditory Injury under Acoustic Stressors above (see Section 6.4.1.2).

6.5.1.3 Physiological Stress

Marine mammals naturally experience stress within their environment and as part of their life histories. The stress response is a suite of physiological changes that are meant to help an organism mitigate the impact of a stressor. However, if the magnitude and duration of the stress response is too great or too long, then it can have negative consequences to the organism (e.g., decreased immune function, decreased reproduction). The Conceptual Framework for Assessing Effects from Sound-Producing Activities (see Section 6.2) provides additional information on physiological stress and the framework used to analyze this potential impact.

There are no direct measurements of physiological stress in marine mammals due to exposure to explosive sources. General research findings regarding physiological stress in marine mammals due to exposure to sound and other stressors are discussed in detail in Physiological Stress under Acoustic Stressors above (see Section 6.4.1.3). Because there are many unknowns regarding the occurrence of acoustically induced stress responses in marine mammals, it is assumed that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response.

6.5.1.4 Masking

Masking occurs when one sound, distinguished as the 'noise', interferes with the detection or recognition of another sound. The quantitative definition of masking is the amount in decibels an auditory detection or discrimination threshold is raised in the presence of a masker (Erbe et al., 2015).

As discussed in the Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 6.2), masking can effectively limit the distance over which a marine mammal can communicate, detect biologically relevant sounds, and echolocate (odontocetes). Masking only occurs in the presence of the masking noise and does not persist after the cessation of the noise. Masking may lead to a change in vocalizations or a change in behavior (e.g., cessation of foraging, leaving an area).

There are no direct observations of masking in marine mammals due to exposure to explosive sources. General research findings regarding masking in marine mammals due to exposure to sound and other stressors are discussed in detail in Masking under Acoustic Stressors above (see Section 6.4.1.4). Potential masking from explosive sounds is likely to be similar to masking studied for other impulsive sounds such as air guns.

6.5.1.5 Reactions

As discussed in Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 6.2), any stimuli in the environment can cause a behavioral response in marine mammals, including noise from explosions. There are no direct observations of behavioral reactions from marine mammals due to exposure to explosive sounds. Behavioral reactions from explosive sounds are likely to be similar to reactions studied for other impulsive sounds such as those produced by air guns. Impulsive signals, particularly at close range, have a rapid rise time and higher instantaneous peak pressure than other signal types, making them more likely to cause startle responses or avoidance responses. Most data has come from seismic surveys that occur over long durations (e.g., on the order of days to weeks), and typically utilize large multi-air gun arrays that fire repeatedly. While seismic air gun data (as presented in 6.4.1.5.1 Acoustic Stressors) provides the best available science for assessing behavioral responses to impulsive sounds (i.e., sounds from explosives) by marine mammals, it is likely that these responses represent a worst-case scenario compared to most Navy explosive noise sources.

General research findings regarding behavioral reactions from marine mammals due to exposure to impulsive sounds, such as those associated with explosions, are discussed in detail in Behavioral Reactions under Acoustic Stressors above (see Section 6.4.1.5).

6.5.1.6 Stranding

When a marine mammal (alive or dead) swims or floats onto shore and becomes beached or incapable of returning to sea, the event is termed a “stranding” (Geraci et al., 1999; Geraci & Lounsbury, 2005; Perrin & Geraci, 2002). Specifically, under U.S. law, a stranding is an event in the wild where: (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance” (16 United States Code section 1421h).

Impulsive sources (e.g., explosions) also have the potential to contribute to strandings, but such occurrences are even less common than those that have been related to certain sonar activities. During a Navy training event on March 4, 2011, at the Silver Strand Training Complex in San Diego, California, four long-beaked common dolphins were killed by an underwater detonation. Further details are

provided above. Discussions of procedures associated with these and other training and testing exercises are presented in Chapter 11 (Mitigation Measures), which details all mitigations.

6.5.1.7 Long-Term Consequences

Long-term consequences to a population are determined by examining changes in the population growth rate. For additional information on the determination of long-term consequences, see Conceptual Framework for Assessing Effects from Sound-Producing Activities (Section 6.2). Physical effects from explosive sources that could lead to a reduction in the population growth rate include mortality or injury, which could remove animals from the reproductive pool, and permanent hearing impairment or chronic masking, which could impact navigation, foraging, predator avoidance, or communication. The long-term consequences due to individual behavioral reactions, masking and short-term instances of physiological stress are especially difficult to predict because individual experience over time can create complex contingencies, especially for long-lived animals like marine mammals. For example, a lost reproductive opportunity could be a measureable cost to the individual; however, short-term costs may be recouped during the life of an otherwise healthy individual. These factors are taken into consideration when assessing risk of long-term consequences.

6.5.2 Impacts from Explosives

Marine mammals could be exposed to energy, sound, and fragments from underwater explosions associated with the proposed activities. Energy from an explosion is capable of causing mortality, injury, hearing loss, a behavioral response, masking, or physiological stress, depending on the level and duration of exposure.

The death of an animal would eliminate future reproductive potential, which is considered in the analysis of potential long-term consequences to the population. Exposures that result in non-auditory injuries or PTS may limit an animal's ability to find food, communicate with other animals, or interpret the surrounding environment. Impairment of these abilities can decrease an individual's chance of survival or impact its ability to successfully reproduce. TTS can also impair an animal's abilities, but the individual is likely recover quickly with little significant effect.

Explosions in the ocean or near the water surface can introduce loud, impulsive, broadband sounds into the marine environment. These sounds, which are within the audible range of most marine mammals, could cause behavioral reactions, masking and elevated physiological stress. Behavioral responses can include shorter surfacings, shorter dives, fewer blows (breaths) per surfacing, longer intervals between blows, ceasing or increasing vocalizations, shortening or lengthening vocalizations, and changing frequency or intensity of vocalizations (National Research Council 2005). Sounds from explosions could also mask biologically important sounds; however, the duration of individual sounds is very short, reducing the likelihood of substantial auditory masking.

6.5.2.1 Methods for Analyzing Impacts from Explosives

The Navy performed a quantitative analysis to estimate the number times that marine mammals could be impacted by explosions used during Navy training and testing activities. The Navy Acoustic Effects Model is used to produce initial estimates of the number of instances that animals that may experience these effects; these estimates are further refined by considering animal avoidance of sound-producing activities and implementation of mitigation. A detailed explanation of this analysis is provided in the

technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

6.5.2.1.1 Criteria and Thresholds used to Estimate Impacts to Marine Mammals from Explosives

See the *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* technical report (U.S. Department of the Navy, 2017d) for detailed information on how the criteria and thresholds were derived.

6.5.2.1.1.1 Mortality and Injury from Explosives

As discussed above in Section 6.5.1.1 (Injury), two metrics have been identified as predictive of injury: impulse and peak pressure. Peak pressure contributes to the “crack” or “stinging” sensation of a blast wave, compared to the “thump” associated with received impulse. Older military reports documenting exposure of human divers to blast exposure generally describe peak pressure exposures around 100 psi (237 dB re 1 µPa SPL peak) to feel like slight pressure or stinging sensation on skin, with no enduring effects (Christian & Gaspin, 1974).

Because data on explosive injury do not indicate a set threshold for injury, rather a range of risk for explosive exposures, two sets of criteria are provided for use in non-auditory injury assessment. The first set provides thresholds to estimate the number of animals that may be affected during Navy training and testing activities (see Table 6-38).

The second set (Table 6-39) provides thresholds for the onset of the effect to estimate farthest range for potential occurrence of an effect. Both sets of criteria are useful for assessing potential effects to marine mammals and the range at which mitigation could be effective. Increasing animal mass and increasing animal depth both increase the impulse thresholds (i.e., decrease susceptibility), whereas smaller mass and decreased animal depth reduce the impulse thresholds (i.e., increase susceptibility). For impact assessment, marine mammal populations are assumed to be 70 percent adult and 30 percent calf/pup. Sub-adult masses are used to determine onset of effect, in order to estimate the farthest range at which an effect may first be observable. The derivation of these injury criteria and the species mass estimates are provided in the technical report *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis (Phase III)* (U.S. Department of the Navy, 2017c).

Table 6-38: Criteria to Quantitatively Assess Non-Auditory Injury Due to Underwater Explosions

Impact Assessment Criterion	*Threshold*
50% Mortality (Impulse)	$144M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
50% Injury (Impulse)	$65.8M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Injury (Peak Pressure)	243 dB re 1 µPa SPL peak

dB re 1 µPa: decibels referenced to 1 micropascal; Pa-s: pascal second; SPL: sound pressure level; D = depth of animal (m); M = mass of animal (kg)

Table 6-39: Onset of Effect Threshold for Estimating Ranges to Potential Effect For Establishment Of Mitigation Zones

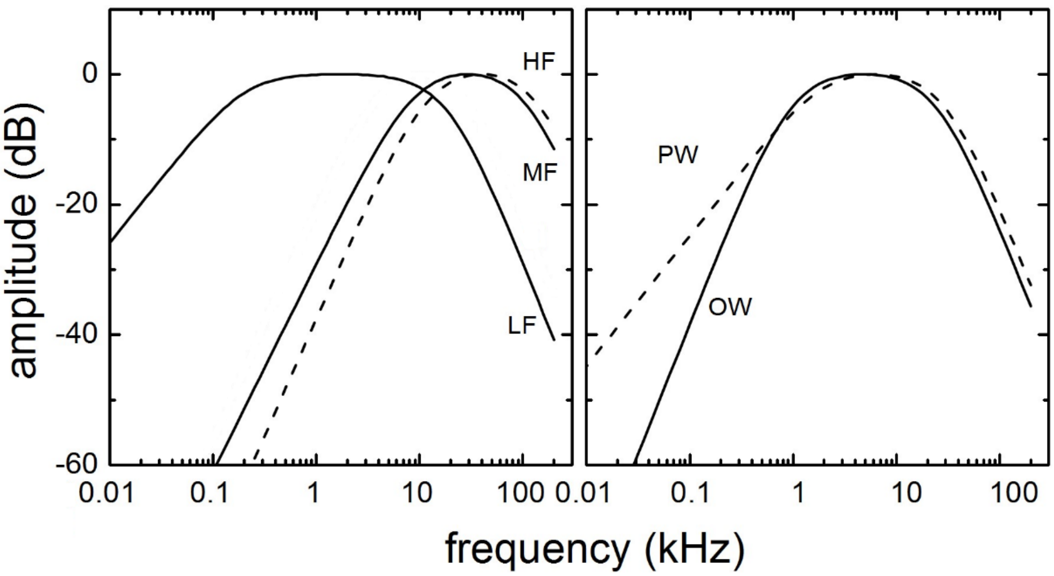
Mitigation Criterion	*Threshold*
Onset Mortality (Impulse)	$103M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury (Impulse)	$47.5M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/6}$ Pa-s
Onset Injury (Peak Pressure)	237 dB re 1 µPa SPL peak

dB re 1 µPa: decibels referenced to 1 micropascal; Pa-s: pascal second; SPL: sound pressure level; D = depth of animal (m); M = mass of animal (kg)

When explosive ordnance (e.g., bomb or missile) detonates, fragments of the weapon are thrown at high-velocity from the detonation point, which can injure or kill marine mammals if they are struck. Risk of fragment injury reduces exponentially with distance as the fragment density is reduced. Fragments underwater tend to be larger than fragments produced by in-air explosions (Swisdak & Montaro, 1992). Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat. On the other hand, the blast wave from an explosive detonation moves efficiently through the seawater. Because the ranges to mortality and injury due to exposure to the blast wave are likely to far exceed the zone where fragments could injure or kill an animal, the above threshold are assumed to encompass risk due to fragmentation.

6.5.2.1.1.2 Auditory Weighting Functions

Animals are not equally sensitive to noise at all frequencies. To capture the frequency-dependent nature of the effects of noise, auditory weighting functions are used. Auditory weighting functions are mathematical functions based on a generic band-pass filter and incorporate species-specific hearing abilities to calculate a weighted received sound level in units SPL or SEL. Due to the band pass nature of auditory weighting functions, they resemble an inverted "U" shape with amplitude plotted as a function of frequency. The flatter portion of the plotted function, where the amplitude is closest to zero, is the emphasized frequency range (i.e., the pass-band), while the frequencies below and above this range (where amplitude declines) are de-emphasized.

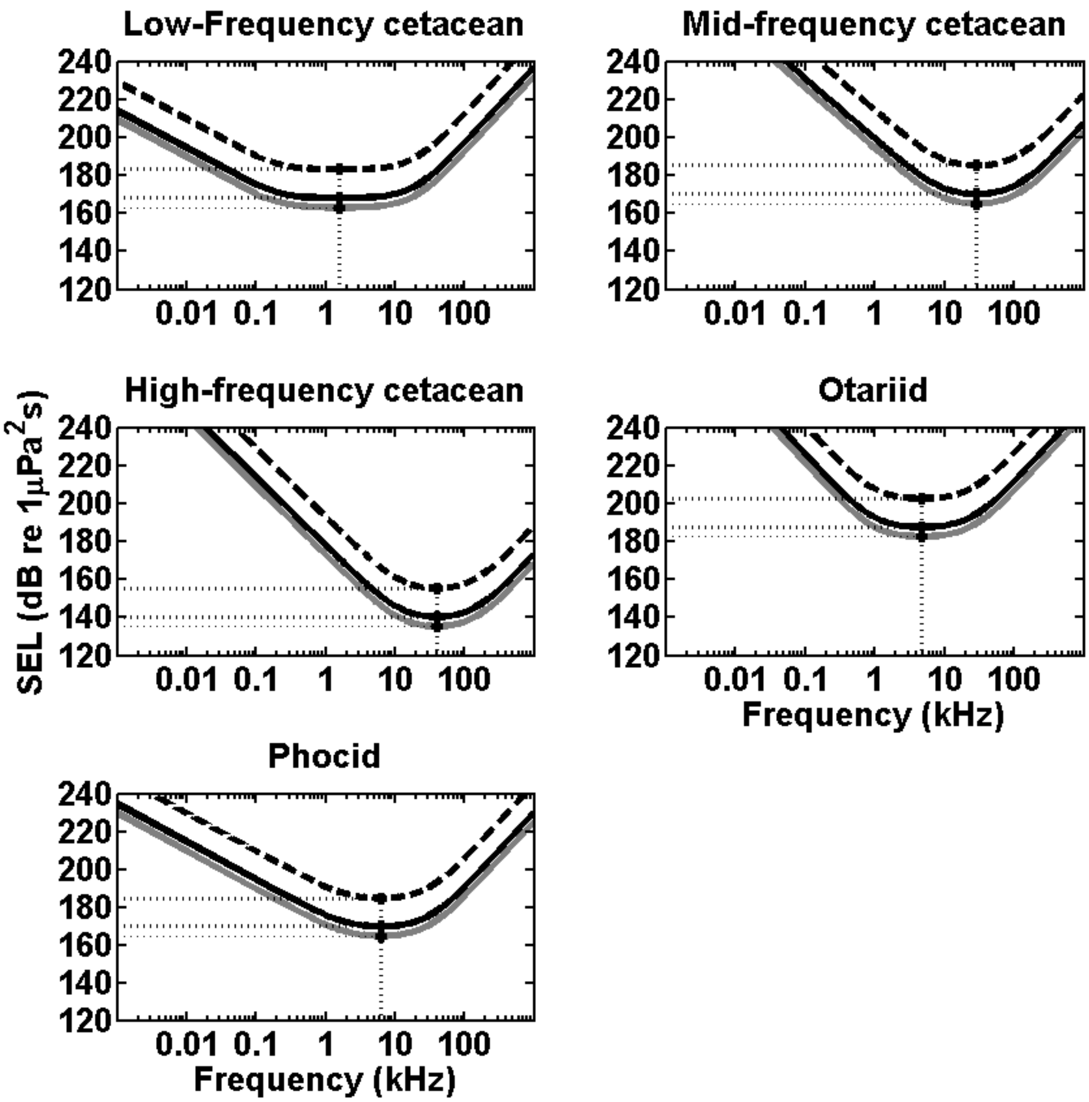


For parameters used to generate the functions and more information on weighting function derivation see (Finneran, 2015). MF = Mid-Frequency Cetacean; HF = High-Frequency Cetacean; LF = Low-Frequency Cetacean; PW = Phocid (in-water); OW = Otariid (in-water)

Figure 6-54: Navy Phase 3 Weighting Functions for All Species Groups

6.5.2.1.1.3 Hearing Loss from Explosives

Criteria used to define threshold shifts from explosions are derived from the two known studies designed to induce TTS in marine mammals from impulsive sources. Finneran et al. (2002) reported behaviorally-measured TTS of 6 and 7 dB in a beluga exposed to single impulses from a seismic water gun and Lucke et al. (2009) reported auditory evoked potential-measured TTS of 7 to 20 dB in a harbor porpoise exposed to single impulses from a seismic air gun. Since marine mammal PTS data from impulsive noise exposures do not exist, onset-PTS levels for all groups were estimated by adding 15 dB to the threshold for non-impulsive sources. This relationship was derived by Southall et al. (2007) from impulsive noise TTS growth rates in chinchillas. These frequency dependent thresholds are depicted by the exposure functions for each group's range of best hearing (see Figure 6-55 and Table 6-40).



The dark dashed curve is the exposure function for PTS onset, the solid black curve is the exposure function for TTS onset, and the light grey curve is the exposure function for behavioral response. Small dashed lines indicate the SEL threshold for behavioral response, TTS, and PTS onset at each group's most sensitive frequency (i.e., the weighted SEL threshold).

Figure 6-55: Navy Phase III Behavioral, TTS and PTS Exposure Functions for Explosives

Table 6-40: Navy Phase III Weighted Sound Exposure Level Behavioral Response, Temporary Threshold and Permanent Onset Thresholds and Unweighted Peak Sound Pressure Level Temporary Threshold and Permanent Onset Thresholds for Underwater Explosive Sounds

Hearing Group	*Explosive Sound Source*				
	Behavior (SEL) weighted (dB)	*TTS (SEL) weighted (dB)*	*TTS (Peak SPL) unweighted (dB)*	*PTS (SEL) weighted (dB)*	*PTS (Peak SPL) unweighted (dB)*
Low-frequency Cetacean	163	168	213	183	219
Mid-frequency Cetacean	165	170	224	185	230
High-frequency Cetacean	135	140	196	155	202
Otariids in water	183	188	226	203	232
Phocid seal in water	165	170	212	185	218

dB: decibels; PTS: permanent threshold shift; SEL: sound exposure level; SPL: sound pressure level; TTS: temporary threshold shift

6.5.2.1.1.4 Behavioral Responses from Explosives

If more than one explosive event occurs within any given 24-hour period within a training or testing activity, criteria are applied to predict the number of animals that may have a behavioral reaction. For exercises with multiple explosions, the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold (in SEL). This value is derived from observed onsets of behavioral response by test subjects (bottlenose dolphins) during non-impulsive TTS testing (Schlundt et al., 2000).

Some multiple explosive exercises, such as certain naval gunnery exercises, may be treated as a single event because a few explosions occur closely spaced within a very short time (a few seconds). For single explosions at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response. Since no further sounds follow the initial brief impulses, significant behavioral reactions would not be expected to occur. This reasoning was applied to previous shock trials (63 FR 230; 66 FR 87; 73 FR 143) and is extended to the criteria used in this analysis.

6.5.2.1.2 Marine Mammal Density

A quantitative analysis of impacts on a species requires data on their abundance and distribution in the potentially impacted area. The most appropriate metric for this type of analysis is density, which is the number of animals present per unit area. To characterize the marine species density for large areas such as the Study Area, the Navy compiled data from several sources. The Navy developed a protocol to select the best available data sources based on species, area, and time (season). The resulting Geographic Information System database called the *Navy Marine Species Density Database* includes seasonal density values for every marine mammal species present within the Study Area (U.S. Department of the Navy, 2017e).

The models used to estimate density for a specific species or stock in a specific area, as described in in the HSTT Density Technical Report, should be considered when examining the estimated impact numbers in comparison to current population abundance information for any given species or stock. For a detailed description of the density and assumptions made for each species, see the Density Technical Report.

6.5.2.1.3 The Navy's Acoustic Effects Model

The Navy's Acoustic Effects Model calculates sound energy propagation from explosions during naval activities and the sound received by animat dosimeters. Animat dosimeters are virtual representations of marine mammals distributed in the area around the modeled naval activity that each record its individual sound 'dose.' The model bases the distribution of animats over the Study Area on the density values in the *Navy Marine Species Density Database* and distributes animats in the water column proportional to the known time that species spend at varying depths.

The model accounts for environmental variability of sound propagation in both distance and depth when computing the received sound level on the animats. The model conducts a statistical analysis based on multiple model runs to compute the estimated effects on animals. The number of animats that exceed the thresholds for effects is tallied to provide an estimate of the number of marine mammals that could be affected.

Assumptions in the Navy model intentionally err on the side of overestimation when there are unknowns.

- Naval activities are modeled as though they would occur regardless of proximity to marine mammals (i.e., mitigation is not modeled) and without any avoidance of the activity by the animal. The final step of the quantitative analysis of acoustic effects is to consider the implementation of mitigation.
- Many explosions from ordnance such as bombs and missiles actually occur upon impact with above-water targets. However, for this analysis, sources such as these were modeled as exploding underwater. This overestimates the amount of explosive and acoustic energy entering the water.

The model estimates the impacts caused by individual training and testing exercises. During any individual modeled event, impacts to individual animats are considered over 24-hour periods. The animats do not represent actual animals, but rather allow for a statistical analysis of the number of instances that marine mammals may be exposed to sound levels resulting in an effect. Therefore, the model estimates the number of instances in which an effect threshold was exceeded over the course of a year, but does not estimate the number of individual marine mammals that may be impacted over a year (i.e., some marine mammals could be impacted several times, while others would not experience any impact). A detailed explanation of the Navy's Acoustic Effects Model is provided in the technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

6.5.2.1.4 Accounting for Mitigation

The Navy implements mitigation measures (described in Chapter 11, Mitigation Measures) during explosive activities, including delaying detonations when a marine mammal is observed in the mitigation zone. The mitigation zones encompass the estimated ranges to mortality for a given explosive. Therefore, the impact analysis quantifies the potential for mitigation to reduce the risk of mortality due to exposure to explosives. Two factors are considered when quantifying the effectiveness of mitigation: (1) the extent to which the type of mitigation proposed for a sound-producing activity (e.g., active sonar) allows for observation of the mitigation zone prior to and during the activity; and (2) the sightability of each species that may be present in the mitigation zone, which is determined by species-specific characteristics and the viewing platform. A detailed explanation of the analysis is provided in the

technical report *Quantitative Analysis for Estimating Acoustic and Explosive Impacts to Marine Mammals and Sea Turtles* (U.S. Department of the Navy, 2017d).

In the quantitative analysis, consideration of mitigation measures means that, for activities where mitigation is feasible, model-estimated mortality is considered mitigated to the level of injury. The impact analysis does not analyze the potential for mitigation to reduce non-auditory injury, PTS, TTS or behavioral effects, even though mitigation would also reduce the likelihood of these effects. In practice, mitigation also protects all unobserved (below the surface) animals in the vicinity, including other species, in addition to the observed animal. However, the analysis assumes that only animals sighted at the water surface would be protected by the applied mitigation. The analysis, therefore, does not capture the protection afforded to all marine species that may be near or within the mitigation zone.

6.5.2.2 Impact Ranges for Explosives

The following section provides the range (distance) over which specific physiological or behavioral effects are expected to occur based on the explosive criteria (Section 6.5.2.1.1, Criteria and Thresholds Used to Estimate Impacts to Marine Mammals from Explosives) and the explosive propagation calculations from the Navy Acoustic Effects Model (Section 6.5.2.1.3, Navy Acoustic Effects Model). The range to effects are shown for a range of explosive bins (Section 6.5.2.2, Impact Ranges from Explosives), from E1 (up to 0.25 lb. net explosive weight) to E12 (up to 1,000 lb. net explosive weight). Ranges are determined by modeling the distance that noise from an explosion will need to propagate to reach exposure level thresholds specific to a hearing group that will cause behavioral response, TTS, PTS, and non-auditory injury. Range to effects is important information in not only predicting impacts from explosives, but also in verifying the accuracy of model results against real-world situations and determining adequate mitigation ranges to avoid higher level effects, especially physiological effects to marine mammals.

Ranges to mortality, based on animal mass, are shown in Table 6-41 and Table 6-42 which show the minimum, average, and maximum ranges due to varying propagation conditions to non-auditory injury as a function of animal mass and explosive bin (i.e. net explosive weight). These ranges represent the larger of the range to slight lung injury or gastrointestinal tract injury for representative animal masses ranging from 5 to 72,000 kg and different explosive bins ranging from 0.25 to 1,000 lb. net explosive weight. Animals within these water volumes would be expected to receive minor injuries at the outer ranges, increasing to more substantial injuries, and finally mortality as an animal approaches the detonation point. The following tables (Table 6-43 through Table 6-52).

Table 6-) show the minimum, average, and maximum ranges to onset of auditory and behavioral effects based on the thresholds described in Section 6.5.2.1.1 (Criteria and Thresholds Used to Estimate Impacts to Marine Mammals from Explosives). Ranges are provided for a representative source depth and cluster size for each bin. For events with multiple explosions, sound from successive explosions can be expected to accumulate and increase the range to the onset of an impact based on SEL thresholds. Modeled ranges to TTS and PTS based on peak pressure for a single explosion generally exceed the modeled ranges based on SEL even when accumulated for multiple explosions. Peak pressure based ranges are estimated using the best available science; however, data on peak pressure at far distances from explosions are very limited. For additional information on how ranges to impacts from explosions were estimated, see the technical report *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing Ranges* (U.S. Department of the Navy, 2017b).

Table 6-41: Ranges[1] to 50 % Mortality Risk for All Marine Mammal Hearing Groups as a Function of Animal Mass

Bin	*Animal Mass Intervals (kg)[1]*					
	10	*250*	*1,000*	*5,000*	*25,000*	*72,000*
E1	3 (2—3)	0 (0—3)	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)
E2	4 (3—5)	1 (0—4)	0 (0—0)	0 (0—0)	0 (0—0)	0 (0—0)
E3	8 (6—10)	4 (2—8)	1 (0—2)	0 (0—0)	0 (0—0)	0 (0—0)
E4	15 (0—35)	9 (0—30)	4 (0—8)	2 (0—6)	0 (0—3)	0 (0—2)
E5	13 (11—45)	7 (4—35)	3 (3—12)	2 (0—8)	0 (0—2)	0 (0—2)
E6	18 (14—55)	10 (5—45)	5 (3—15)	3 (2—10)	0 (0—3)	0 (0—2)
E7	67 (55—180)	35 (18—140)	16 (12—30)	10 (8—20)	5 (4—9)	4 (3—7)
E8	50 (24—110)	27 (9—55)	13 (0—20)	9 (4—13)	4 (0—6)	3 (0—5)
E9	32 (30—35)	20 (13—30)	10 (8—12)	7 (6—9)	4 (3—4)	3 (2—3)
E10	56 (40—190)	25 (16—130)	13 (11—16)	9 (7—11)	5 (4—5)	4 (3—4)
E11	211 (180—500)	109 (60—330)	47 (40—100)	30 (25—65)	15 (0—25)	13 (11—22)
E12	94 (50—300)	35 (20—230)	16 (13—19)	11 (9—13)	6 (5—8)	5 (4—8)

[1]Average distance (m) to mortality is depicted above the minimum and maximum distances which are in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location
Differences between bins E11 and E12 due to different ordnance types and differences in model parameters (see Table 6-42 for details)

Table 6-42: Ranges[1] to 50 % Non-Auditory Injury for All Marine Mammal Hearing Groups as a Function of Animal Mass (10-72,000 kg)

Bin	*Range (m) (min-max)*
E1	12 (11—13)
E2	15 (15—20)
E3	25 (25—30)
E4	32 (0—75)
E5	40 (35—140)
E6	52 (40—120)
E7	145 (100—500)
E8	117 (75—400)
E9	120 (90—290)
E10	174 (100—480)
E11	443 (350—1,775)
E12	232 (110—775)

- E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location
- Differences between bins E11 and E12 due to different ordnance types and differences in model parameters

Table 6-43: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	353 (130—825)	1,234 (290—3,025)	2,141 (340—4,775)
		25	1,188 (280—3,025)	3,752 (490—8,525)	5,196 (675—12,275)
E2	0.1	1	425 (140—1,275)	1,456 (300—3,525)	2,563 (390—5,275)
		10	988 (280—2,275)	3,335 (480—7,025)	4,693 (650—10,275)
E3	0.1	1	654 (220—1,525)	2,294 (350—4,775)	3,483 (490—7,775)
		12	1,581 (300—3,525)	4,573 (650—10,275)	6,188 (725—14,775)
	18.25	1	747 (550—1,525)	3,103 (950—6,025)	5,641 (1,000—9,275)
		12	1,809 (875—4,025)	7,807 (1,025—12,775)	10,798 (1,025—17,775)
E4	3	2	2,020 (1,025—3,275)	3,075 (1,025—6,775)	3,339 (1,025—9,775)
	15.25	2	970 (600—1,525)	4,457 (1,025—8,525)	6,087 (1,275—12,025)
	19.8	2	1,023 (1,000—1,025)	4,649 (2,275—8,525)	6,546 (3,025—11,025)
	198	2	959 (875—1,525)	4,386 (3,025—7,525)	5,522 (3,025—9,275)
E5	0.1	25	2,892 (440—6,275)	6,633 (725—16,025)	8,925 (800—22,775)
	15.25	25	4,448 (1,025—7,775)	10,504 (1,525—18,275)	13,605 (1,775—24,775)
E6	0.1	1	1,017 (280—2,525)	3,550 (490—7,775)	4,908 (675—12,275)
	3	1	2,275 (2,025—2,525)	6,025 (4,525—7,275)	7,838 (6,275—9,775)
	15.25	1	1,238 (625—2,775)	5,613 (1,025—10,525)	7,954 (1,275—14,275)
E7	3	1	3,150 (2,525—3,525)	7,171 (5,525—8,775)	8,734 (7,275—10,525)
	18.25	1	2,082 (925—3,525)	6,170 (1,275—10,525)	8,464 (1,525—16,525)
E8	0.1	1	1,646 (775—2,525)	4,322 (1,525—9,775)	5,710 (1,525—14,275)
	45.75	1	1,908 (1,025—4,775)	5,564 (1,525—12,525)	7,197 (1,525—18,775)
E9	0.1	1	2,105 (850—4,025)	4,901 (1,525—12,525)	6,700 (1,525—16,775)
E10	0.1	1	2,629	5,905	7,996

Range to Effects for Explosives: High Frequency Cetacean[1]					
Bin	Source Depth (m)	Cluster Size	PTS	TTS	Behavioral
			(875—5,275)	(1,525—13,775)	(1,525—20,025)
E11	18.5	1	3,034 (1,025—6,025)	7,636 (1,525—16,525)	9,772 (1,775—21,525)
	45.75	1	2,925 (1,525—6,025)	7,152 (2,275—18,525)	9,011 (2,525—24,525)
E12	0.1	1	2,868 (975—5,525)	6,097 (2,275—14,775)	8,355 (4,275—21,275)
		3	3,762 (1,525—8,275)	7,873 (3,775—20,525)	10,838 (4,275—26,525)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-44: Peak Pressure Based Ranges to Onset PTS and Onset TTS for High-Frequency Cetaceans

Range to Effects for Explosives: High Frequency Cetacean[1]			
Bin	Source Depth (m)	PTS	TTS
E1	0.1	660 (170—1,025)	1,054 (270—1,775)
E2	0.1	806 (190—2,025)	1,280 (300—6,025)
E3	0.1	1,261 (290—6,025)	2,068 (480—9,025)
	18.25	1,615 (925—5,275)	2,813 (1,025—6,775)
E4	3	2,466 (1,025—4,025)	2,823 (1,025—4,275)
	15.25	2,524 (1,025—6,525)	4,955 (1,775—11,025)
	19.8	2,113 (1,275—3,025)	3,570 (1,775—6,275)
	198	3,682 (2,275—7,025)	5,586 (3,025—11,275)
E5	0.1	1,869 (410—7,775)	2,751 (600—13,275)
	15.25	2,908 (1,525—7,775)	5,291 (2,025—11,775)
E6	0.1	2,177 (525—9,275)	3,136 (625—14,025)
	3	2,817 (2,525—3,525)	4,817 (4,025—5,775)
	15.25	4,061 (1,775—11,275)	6,726 (2,025—16,775)
E7	3	4,525 (3,775—5,275)	6,171 (5,525—7,525)
	18.25	5,496	8,114

Range to Effects for Explosives: High Frequency Cetacean[1]			
Bin	Source Depth (m)	PTS	TTS
		(2,525—12,775)	(3,025—14,275)
E8	0.1	2,986 (925—5,775)	3,806 (1,525—9,775)
	45.75	4,916 (1,525—13,525)	7,111 (2,275—27,775)
E9	0.1	3,365 (1,275—8,025)	4,409 (1,525—13,525)
E10	0.1	3,791 (1,275—9,775)	5,540 (1,775—26,025)
E11	18.5	10,062 (4,025—23,025)	13,369 (5,025—33,025)
	45.75	7,635 (2,275—31,025)	12,673 (3,775—37,775)
E12	0.1	4,110 (1,525—13,525)	5,603 (2,025—21,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-45: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetacean[1]					
Bin	Source Depth (m)	Cluster Size	PTS	TTS	Behavioral
E1	0.1	1	51 (40—70)	227 (100—320)	124 (70—160)
		25	205 (95—270)	772 (270—1,275)	476 (190—725)
E2	0.1	1	65 (45—95)	287 (120—400)	159 (80—210)
		10	176 (85—240)	696 (240—1,275)	419 (160—625)
E3	0.1	1	109 (65—150)	503 (190—1,000)	284 (120—430)
		12	338 (130—525)	1,122 (320—7,775)	761 (240—6,025)
	18.25	1	205 (170—340)	996 (410—2,275)	539 (330—1,275)
		12	651 (340—1,275)	3,503 (600—8,275)	1,529 (470—3,275)

Range to Effects for Explosives: Low Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E4	3	2	493 (440—1,000)	2,611 (1,025—4,025)	1,865 (950—2,775)
	15.25	2	583 (350—850)	3,115 (1,275—5,775)	1,554 (1,000—2,775)
	19.8	2	378 (370—380)	1,568 (1,275—1,775)	926 (825—950)
	198	2	299 (290—300)	2,661 (1,275—3,775)	934 (900—950)
E5	0.1	25	740 (220—6,025)	2,731 (460—22,275)	1,414 (350—14,275)
	15.25	25	1,978 (1,025—5,275)	8,188 (3,025—19,775)	4,727 (1,775—11,525)
E6	0.1	1	250 (100—420)	963 (260—7,275)	617 (200—1,275)
	3	1	711 (525—825)	3,698 (1,525—4,275)	2,049 (1,025—2,525)
	15.25	1	718 (390—2,025)	3,248 (1,275—8,525)	1,806 (950—4,525)
E7	3	1	1,121 (850—1,275)	5,293 (2,025—6,025)	3,305 (1,275—4,025)
	18.25	1	1,889 (1,025—2,775)	6,157 (2,775—11,275)	4,103 (2,275—7,275)
E8	0.1	1	460 (170—950)	1,146 (380—7,025)	873 (280—3,025)
	45.75	1	1,049 (550—2,775)	4,100 (1,025—14,275)	2,333 (800—7,025)
E9	0.1	1	616 (200—1,275)	1,560 (450—12,025)	1,014 (330—5,025)
E10	0.1	1	787 (210—2,525)	2,608 (440—18,275)	1,330 (330—9,025)
E11	18.5	1	4,315 (2,025—8,025)	10,667 (4,775—26,775)	7,926 (3,275—21,025)
	45.75	1	1,969 (775—5,025)	9,221 (2,525—29,025)	4,594 (1,275—16,025)
E12	0.1	1	815 (250—3,025)	2,676 (775—18,025)	1,383 (410—8,525)
	0.1	3	1,040 (330—6,025)	4,657 (1,275—31,275)	2,377 (700—16,275)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels. E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-46: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Low-Frequency Cetaceans

Range to Effects for Explosives: Low Frequency Cetacean[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	126 (55—140)	226 (90—270)
E2	0.1	161 (65—180)	280 (100—340)
E3	0.1	264 (100—320)	453 (140—600)
	18.25	330 (240—875)	614 (330—1,775)
E4	3	531 (420—625)	916 (650—2,025)
	15.25	525 (350—725)	864 (550—1,275)
	19.8	390 (370—400)	730 (650—800)
	198	379 (340—400)	746 (675—1,525)
E5	0.1	404 (130—525)	679 (180—1,025)
	15.25	547 (360—1,275)	991 (675—1,525)
E6	0.1	496 (150—700)	797 (210—6,025)
	3	817 (650—975)	1,317 (1,025—1,775)
	15.25	735 (420—1,275)	1,266 (875—2,525)
E7	3	1,017 (925—1,025)	1,977 (1,775—2,275)
	18.25	1,246 (875—1,775)	2,368 (1,525—3,775)
E8	0.1	830 (260—1,275)	1,045 (360—1,775)
	45.75	1,306 (550—3,775)	2,008 (675—6,025)
E9	0.1	966 (310—1,525)	1,240 (420—2,525)
E10	0.1	1,057 (330—1,775)	1,447 (450—6,025)
E11	18.5	2,945 (1,025—7,525)	5,497 (2,025—12,525)
	45.75	2,023 (700—6,775)	2,779 (775—11,275)
E12	0.1	1,155 (390—2,025)	1,512 (550—3,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-47: SEL-Based Ranges to Onset PTS, Onset TTS, and Behavioral Reaction for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	25 (25—25)	118 (80—210)	178 (100—320)
		25	107 (75—170)	476 (150—1,275)	676 (240—1,525)
E2	0.1	1	30 (30—35)	145 (95—240)	218 (110—400)
		10	88 (65—130)	392 (140—825)	567 (190—1,275)
E3	0.1	1	50 (45—65)	233 (110—430)	345 (130—600)
		12	153 (90—250)	642 (220—1,525)	897 (270—2,025)
	18.25	1	38 (35—40)	217 (190—900)	331 (290—850)
		12	131 (120—250)	754 (550—1,525)	1,055 (600—2,525)
E4	3	2	139 (110—160)	1,069 (525—1,525)	1,450 (875—1,775)
	15.25	2	71 (70—75)	461 (400—725)	613 (470—750)
	19.8	2	69 (65—70)	353 (350—360)	621 (600—650)
	198	2	49 (0—55)	275 (270—280)	434 (430—440)
E5	0.1	25	318 (130—625)	1,138 (280—3,025)	1,556 (310—3,775)
	15.25	25	312 (290—725)	1,321 (675—2,525)	1,980 (850—4,275)
E6	0.1	1	98 (70—170)	428 (150—800)	615 (210—1,525)
	3	1	159 (150—160)	754 (650—850)	1,025 (1,025—1,025)
	15.25	1	88 (75—180)	526 (450—875)	719 (500—1,025)
E7	3	1	240 (230—260)	1,025 (1,025—1,025)	1,900 (1,775—2,275)
	18.25	1	166 (120—310)	853 (500—1,525)	1,154 (550—1,775)
E8	0.1	1	160 (150—170)	676 (500—725)	942 (600—1,025)
	45.75	1	128 (120—170)	704 (575—2,025)	1,040 (750—2,525)
E9	0.1	1	215 (200—220)	861 (575—950)	1,147 (650—1,525)

Range to Effects for Explosives: Mid-Frequency Cetacean[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E10	0.1	1	275 (250—480)	1,015 (525—2,275)	1,424 (675—3,275)
E11	18.5	1	335 (260—500)	1,153 (650—1,775)	1,692 (775—3,275)
	45.75	1	272 (230—825)	1,179 (825—3,025)	1,784 (1,000—4,275)
E12	0.1	1	334 (310—350)	1,151 (700—1,275)	1,541 (800—3,525)
	0.1	3	520 (450—550)	1,664 (800—3,525)	2,195 (925—4,775)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-48: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Mid-Frequency Cetaceans

Range to Effects for Explosives: Mid-Frequency Cetacean[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	43 (35—45)	81 (45—95)
E2	0.1	57 (40—65)	102 (50—110)
E3	0.1	96 (50—110)	174 (65—210)
	18.25	101 (100—130)	196 (180—725)
E4	3	261 (180—300)	421 (250—460)
	15.25	162 (120—290)	328 (240—725)
	19.8	120 (120—120)	240 (240—240)
	198	117 (80—120)	229 (210—230)
E5	0.1	149 (65—160)	272 (95—300)
	15.25	178 (160—430)	358 (290—825)
E6	0.1	188 (70—230)	338 (110—400)
	3	268 (230—360)	527 (410—625)
	15.25	240 (200—460)	479 (400—725)
E7	3	459 (320—625)	730 (575—900)
	18.25	429 (310—550)	676 (550—800)
E8	0.1	337 (300—370)	580 (400—750)
	45.75	431 (340—1,025)	806 (600—2,275)
E9	0.1	450 (350—525)	757 (450—1,025)
E10	0.1	534 (240—700)	902 (410—1,275)
E11	18.5	896 (725—1,025)	1,577 (1,025—2,275)
	45.75	824 (600—2,775)	1,484 (900—4,775)
E12	0.1	669 (430—925)	1,074 (525—1,525)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses. E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-49: SEL Based Ranges to Onset PTS and Onset TTS for Otariids

Range to Effects for Explosives: Otariids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	7 (7—7)	34 (30—40)	56 (45—70)
		25	30 (25—35)	136 (80—180)	225 (100—320)
E2	0.1	1	9 (9—9)	41 (35—55)	70 (50—95)
		10	25 (25—30)	115 (70—150)	189 (95—250)
E3	0.1	1	16 (15—19)	70 (50—95)	115 (70—150)
		12	45 (35—65)	206 (100—290)	333 (130—450)
	18.25	1	15 (15—15)	95 (90—100)	168 (150—310)
		12	55 (50—60)	333 (280—750)	544 (440—1,025)
E4	3	2	64 (40—85)	325 (240—340)	466 (370—490)
	15.25	2	30 (30—35)	205 (170—300)	376 (310—575)
	19.8	2	25 (25—25)	170 (170—170)	290 (290—290)
	198	2	17 (0—25)	117 (110—120)	210 (210—210)
E5	0.1	25	98 (60—120)	418 (160—575)	626 (240—1,000)
	15.25	25	151 (140—260)	750 (650—1,025)	1,156 (975—2,025)
E6	0.1	1	30 (25—35)	134 (75—180)	220 (100—320)
	3	1	53 (50—55)	314 (280—390)	459 (420—525)
	15.25	1	36 (35—40)	219 (200—380)	387 (340—625)
E7	3	1	93 (90—100)	433 (380—500)	642 (550—800)
	18.25	1	73 (70—75)	437 (360—525)	697 (600—850)
E8	0.1	1	50 (50—50)	235 (220—250)	385 (330—450)
	45.75	1	55 (55—60)	412 (310—775)	701 (500—1,525)
E9	0.1	1	68 (65—70)	316 (280—360)	494 (390—625)
E10	0.1	1	86	385	582

Range to Effects for Explosives: Otariids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
			(80—95)	(240—460)	(390—800)
E11	18.5	1	158 (150—200)	862 (750—975)	1,431 (1,025—2,025)
	45.75	1	117 (110—130)	756 (575—1,525)	1,287 (950—2,775)
E12	0.1	1	104 (100—110)	473 (370—575)	709 (480—1,025)
	0.1	3	172 (170—180)	694 (480—1,025)	924 (575—1,275)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-50: Peak Pressure Based Ranges to Onset PTS and Onset TTS for Otariids

Range to Effects for Explosives: Otariids[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	35 (30—40)	64 (40—95)
E2	0.1	45 (35—50)	82 (45—95)
E3	0.1	77 (45—95)	133 (60—150)
	18.25	81 (80—100)	163 (150—480)
E4	3	175 (130—210)	375 (220—410)
	15.25	114 (100—190)	252 (190—420)
	19.8	100 (100—100)	190 (190—190)
	198	98 (95—100)	187 (180—190)
E5	0.1	117 (55—130)	212 (80—250)
	15.25	144 (130—310)	278 (240—725)
E6	0.1	148 (65—170)	263 (95—310)
	3	215 (190—260)	463 (330—625)
	15.25	191 (170—410)	386 (310—825)
E7	3	355 (260—500)	614 (490—750)
	18.25	439 (330—550)	628 (575—675)
E8	0.1	272 (260—280)	482 (370—525)
	45.75	401 (280—950)	770 (500—1,775)
E9	0.1	368 (320—400)	610 (420—800)
E10	0.1	442 (230—525)	715 (330—1,025)
E11	18.5	765 (625—1,000)	1,342 (950—2,025)
	45.75	811 (525—2,025)	1,498 (850—3,525)
E12	0.1	550 (400—700)	881 (500—1,275)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-51: SEL-Based Ranges to PTS, TTS, and Behavioral Reaction for Phocids

Range to Effects for Explosives: Phocids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E1	0.1	1	45 (40—65)	210 (100—290)	312 (130—430)
		25	190 (95—260)	798 (280—1,275)	1,050 (360—2,275)
E2	0.1	1	58 (45—75)	258 (110—360)	383 (150—550)
		10	157 (85—240)	672 (240—1,275)	934 (310—1,525)
E3	0.1	1	96 (60—120)	419 (160—625)	607 (220—900)
		12	277 (120—390)	1,040 (370—2,025)	1,509 (525—6,275)
	18.25	1	118 (110—130)	621 (500—1,275)	948 (700—2,025)
		12	406 (330—875)	1,756 (1,025—4,775)	3,302 (1,025—6,275)
E4	3	2	405 (300—430)	1,761 (1,025—2,775)	2,179 (1,025—3,275)
	15.25	2	265 (220—430)	1,225 (975—1,775)	1,870 (1,025—3,275)
	19.8	2	220 (220—220)	991 (950—1,025)	1,417 (1,275—1,525)
	198	2	150 (150—150)	973 (925—1,025)	2,636 (2,025—3,525)
E5	0.1	25	569 (200—850)	2,104 (725—9,275)	2,895 (825—11,025)
	15.25	25	920 (825—1,525)	5,250 (2,025—10,275)	7,336 (2,275—16,025)
E6	0.1	1	182 (90—250)	767 (270—1,275)	1,011 (370—1,775)
	3	1	392 (340—440)	1,567 (1,275—1,775)	2,192 (2,025—2,275)
	15.25	1	288 (250—600)	1,302 (1,025—3,275)	2,169 (1,275—5,775)
E7	3	1	538 (450—625)	2,109 (1,775—2,275)	2,859 (2,775—3,275)
	18.25	1	530 (460—750)	2,617 (1,025—4,525)	3,692 (1,525—5,275)
E8	0.1	1	311 (290—330)	1,154 (625—1,275)	1,548 (725—2,275)
	45.75	1	488 (380—975)	2,273 (1,275—5,275)	3,181 (1,525—8,025)
E9	0.1	1	416 (350—470)	1,443 (675—2,025)	1,911 (800—3,525)
E10	0.1	1	507 (340—675)	1,734 (725—3,525)	2,412 (800—5,025)

Table 6-51: SEL-Based Ranges to PTS, TTS, and Behavioral Reaction for Phocids (continued)

Range to Effects for Explosives: Phocids[1]					
Bin	**Source Depth (m)**	**Cluster Size**	**PTS**	**TTS**	**Behavioral**
E11	18.5	1	1,029 (775—1,275)	5,044 (2,025—8,775)	6,603 (2,525—14,525)
	45.75	1	881 (700—2,275)	3,726 (2,025—8,775)	5,082 (2,025—13,775)
E12	0.1	1	631 (450—750)	1,927 (800—4,025)	2,514 (925—5,525)
	0.1	3	971 (550—1,025)	2,668 (1,025—6,275)	3,541 (1,775—9,775)

[1]Average distance (m) to PTS, TTS, and behavioral thresholds are depicted above the minimum and maximum distances which are in parentheses. Values depict the range produced by SEL hearing threshold criteria levels.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

Table 6-52: Peak Pressure Based Ranges to Onset PTS ad Onset TTS for Phocids

Range to Effects for Explosives: Phocids[1]			
Bin	**Source Depth (m)**	**PTS**	**TTS**
E1	0.1	144 (60—160)	258 (95—300)
E2	0.1	180 (70—220)	323 (110—370)
E3	0.1	303 (100—350)	533 (150—675)
	18.25	373 (270—950)	697 (470—1,775)
E4	3	548 (470—700)	1,230 (675—2,525)
	15.25	567 (460—750)	927 (675—1,525)
	19.8	459 (440—480)	823 (800—900)
	198	431 (420—440)	864 (800—1,000)
E5	0.1	469 (140—600)	815 (190—6,025)
	15.25	604 (550—900)	1,061 (725—1,775)
E6	0.1	582 (160—775)	910 (230—6,025)
	3	888 (750—1,025)	1,484 (1,025—1,775)
	15.25	822 (650—1,525)	1,426 (875—2,775)
E7	3	1,109 (1,025—1,525)	2,109 (1,775—2,525)
	18.25	1,482 (1,025—2,025)	2,766 (1,775—4,775)
E8	0.1	987 (500—1,275)	1,472 (625—2,025)
	45.75	1,695 (800—4,525)	2,896 (1,275—8,025)
E9	0.1	1,207 (550—1,525)	1,790 (700—3,025)
E10	0.1	1,407 (450—3,275)	2,043 (775—5,275)
E11	18.5	3,311 (1,775—7,025)	5,848 (2,275—12,525)
	45.75	3,053 (1,525—8,275)	4,178 (1,775—11,275)
E12	0.1	1,580 (675—2,525)	2,228 (825—3,775)

[1] Distances in meters (m). Average distance is shown with the minimum and maximum distances due to varying propagation environments in parentheses.
E13 not modeled due to surf zone use and lack of marine mammal receptors at site-specific location

6.5.2.3 Impacts from Explosives under the Proposed Action

The following provides a brief description of training and testing as it pertains to underwater and near-surface explosions under the Action:

- As described in Section 1.5 (Proposed Action), and Section 6.5 (Explosive Stressors), training activities under the Proposed Action would use underwater detonations and explosive ordnance. Within the Proposed Action, most training activities that use explosives reoccur on an annual basis, with some variability year-to-year. Activities that involve underwater detonations and explosive ordnance typically occur more than 3 NM from shore and often in areas designated for explosive use.

- As described in Section 1.5 (Proposed Action), and Section 6.5 (Explosive Stressors), testing activities under the Proposed Action would use underwater detonations and explosive ordnance. Within the Proposed Action, most testing activities that use explosives reoccur on an annual basis. Testing activities using explosions do not normally occur within 3 NM of shore.

6.5.2.3.1 Presentation of Estimated Impacts from the Quantitative Analysis

The results of the analysis of potential impacts to marine mammals from explosives (see above Section 6.5.2.1, Methods for Analyzing Impacts from Explosives) are discussed below. The numbers of potential impacts estimated for individual species of marine mammals from exposure to explosive energy and sound for training activities are shown in Appendix E (Estimated Marine Mammals and Sea Turtle Impacts from Exposure to Acoustic and Explosive Stressors under Navy Training and Testing Activities) of the HSTT Draft EIS/OEIS. Additionally, estimated numbers of potential impacts from the quantitative analysis for each species are presented below (e.g., Figure 6-56). The most likely regions and activity categories from which the impacts could occur are displayed in the bar charts for each species. There is a potential for impacts to occur anywhere within the Study Area where sound and energy from explosives and the species overlap, although only areas or categories where 0.5 percent of the impacts, or greater, are estimated to occur are graphically represented on the bar charts below. All (i.e., grand total) estimated impacts are included in the bar plots, regardless of region or category. The numbers of activities planned can vary slightly from year-to-year. Results are presented for a maximum explosive use year; however, during most years, explosive use would be less resulting in fewer potential impacts. The numbers of explosives used are described in Section 6.5 (Explosive Stressors).

6.5.2.3.2 Mysticetes

Mysticetes may be exposed to sound and energy from explosions associated with training and testing activities throughout the year. Explosions produce sounds that are within the hearing range of mysticetes (see Section 6.3, Marine Mammal Hearing and Vocalization). Potential impacts from explosive energy and sound include non-auditory injury, behavioral reactions, physiological stress, masking, and hearing loss. Impact ranges for mysticetes exposed to explosive sound and energy are discussed under low-frequency cetaceans in Section 6.5.2.2 (Impact Ranges for Explosives).

Mysticetes that do experience TTS from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from TTS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days, depending on the severity of the initial shift, to fully recover. Threshold shifts do not necessarily affect

all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the short period that a mysticete had TTS, social calls from conspecifics could be more difficult to detect or interpret, the ability to detect predators may be reduced, and the ability to detect and avoid sounds from approaching vessels or other stressors might be reduced. It is unclear how or if mysticetes use sound for finding prey or feeding; therefore, it is unknown whether a TTS would affect a mysticete's ability to locate prey or rate of feeding.

Research and observations of auditory masking in marine mammals due to impulsive sounds are discussed in Section 6.5.1.4 (Masking). Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in mysticetes that are nearby, although sounds from explosions last for only a few seconds at most. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for mysticetes in the area over the short duration of the event. Potential costs to mysticetes from masking are similar to those discussed above for TTS, with the primary difference being that the effects of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Section 6.5.2.1.1.4, Behavioral Responses from Explosives) show that if mysticetes are exposed to impulsive sounds such as those from an explosion, they may react in a variety of ways, which may include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, changing vocalization, or showing no response at all. Overall, mysticetes have been observed to be more reactive to acoustic disturbance when a noise source is located directly on their migration route. Mysticetes disturbed while migrating could pause their migration or route around the disturbance. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from mysticetes are likely to be short-term and low to moderate severity.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 6.5.1.3, Physiological Stress. Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosives would not be expected.

6.5.2.3.2.1 Blue Whales (Endangered Species Act-Listed)

Impacts from Explosives under the Proposed Action for Training Activities

Blue whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-56 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-53).

As described for mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

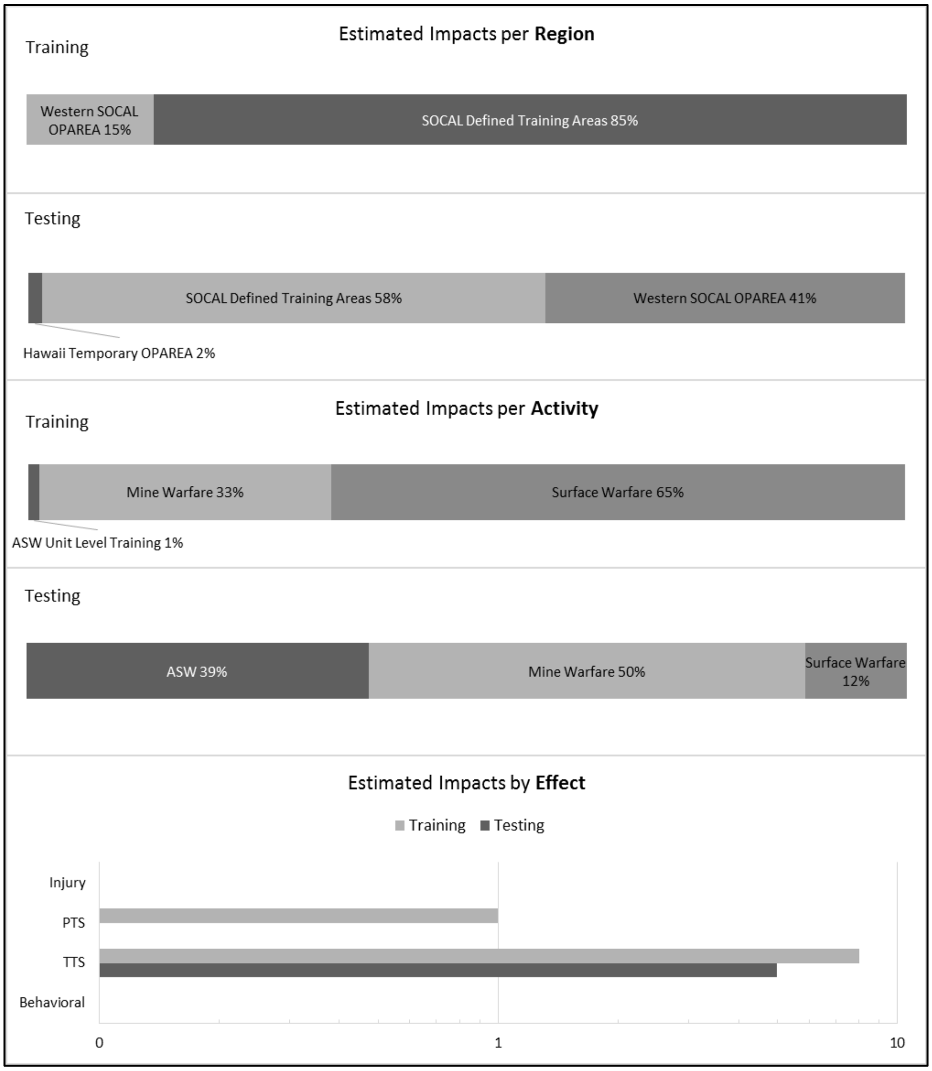
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of blue whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Blue whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-56 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-53).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of blue whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare

Figure 6-56: Blue Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-53: Estimated Impacts on Individual Blue Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Eastern North Pacific	100%	98%
Central North Pacific	0%	2%

6.5.2.3.2.2 Bryde's Whales

Impacts from Explosives under the Proposed Action for Training Activities

Bryde's whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-57 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-54).

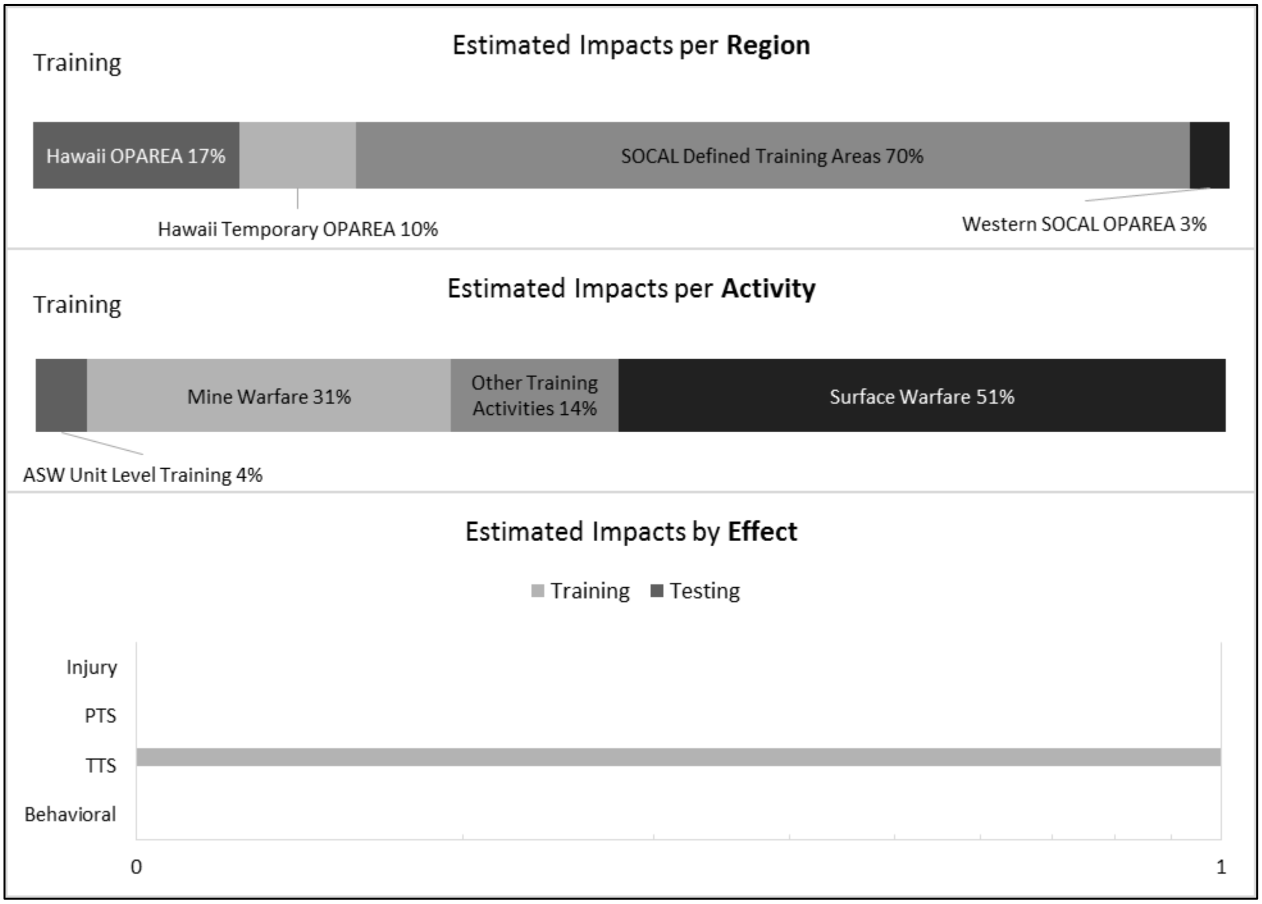
As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Bryde's whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Bryde's whales (Hawaiian and Eastern Tropical Pacific stocks) may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no Bryde's whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will not result in the unintentional taking of Bryde's whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species.

Figure 6-57: Bryde's Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training Under the Proposed Action

Table 6-54: Estimated Impacts on Individual Bryde's Whale Stocks Within the Study Area per Year from Training Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	27%	0%
Eastern Tropical Pacific	73%	0%

6.5.2.3.2.3 Fin Whales (Endangered Species Act-Listed)

Impacts from Explosives under the Proposed Action for Training Activities

Fin whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, and estimates TTS (see Figure 6-58 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-55).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

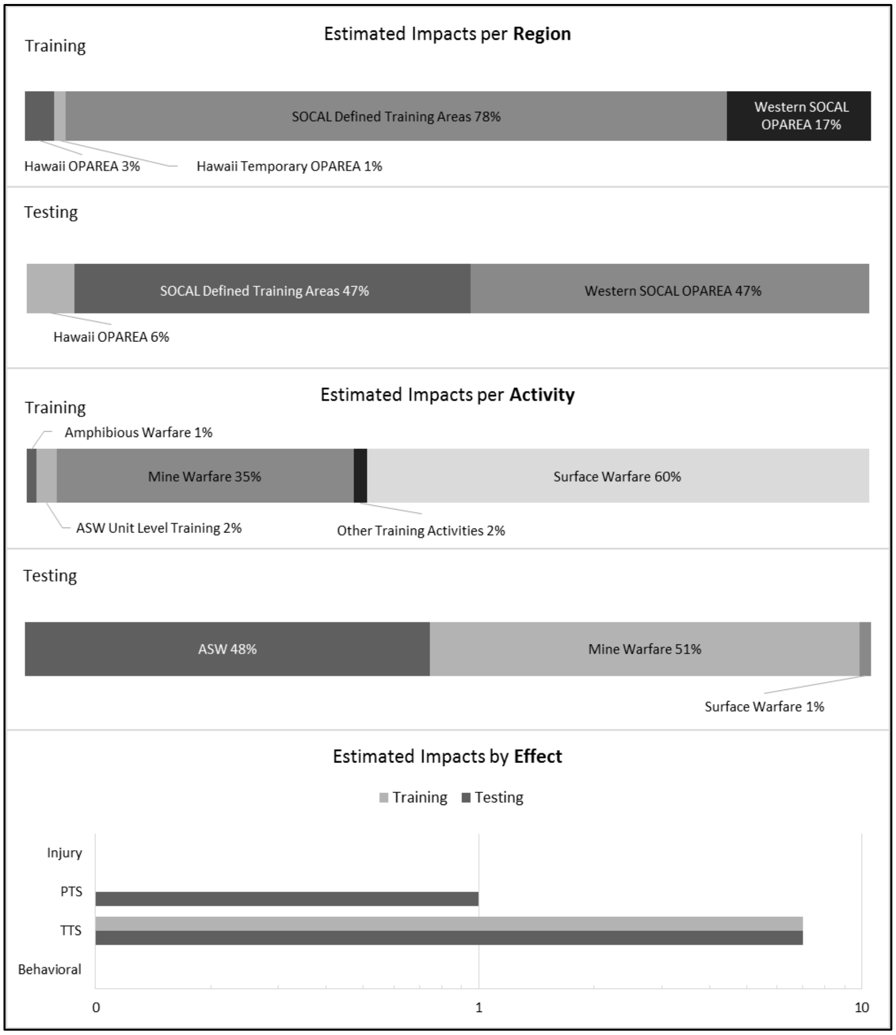
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of fin whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Fin whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-58 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-55).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of fin whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species.

Figure 6-58: Fin Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-55: Estimated Impacts on Individual Fin Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	95%	94%
Hawaiian	5%	6%

6.5.2.3.2.4 Gray Whales

The vast majority of gray whales in the study are from the non-endangered Eastern North Pacific stock, and all of the modeled impacts are for this stock. On rare occasions Western North Pacific gray whales, which are Endangered Species Act-Listed, occur in the Study Area but are not included in this analysis.

Impacts from Explosives under the Proposed Action for Training Activities

Gray whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-59 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Eastern North Pacific stock.

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A migration corridor for gray whales identified by Calambokidis et al. (2015) overlaps the Southern California Range Complex within the Study Area. Navy training activities that use explosives could occur year-round within the Southern California Range Complex; however, within the Southern California Range Complex training with explosives typically occurs only within localized designated areas, which are all small compared to the size of the migration corridor that spreads across the entire southern California Bight (Calambokidis et al. 2015). Gray whales in the identified feeding area could be exposed to limited sound or energy from explosives; therefore, impacts to migration might include a slight shift in migration path or slowing in travel speed as has been observed for migrating gray whales when seismic noise was in their path (e.g., Malme 1984). This would be a low severity behavioral response and would not affect their overall migration behavior within the designated migration corridor.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of gray whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Gray whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-59 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Eastern North Pacific stock.

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single

minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A migration corridor for gray whales identified by Calambokidis et al. (2015) overlaps the Southern California Range Complex within the Study Area. Navy testing activities that use explosives could occur year-round within the Southern California Range Complex; however, within the Southern California Range Complex testing with explosives typically occurs only within localized designated areas, which are all small compared to the size of the migration corridor that spreads across the entire southern California Bight (Calambokidis et al. 2015). Gray whales in the identified feeding area could be exposed to limited sound or energy from explosives; therefore, impacts to migration might include a slight shift in migration path or slowing in travel speed as has been observed for migrating gray whales when seismic noise was in their path (e.g., Malme 1984). This would be a low severity behavioral response and would not affect their overall migration behavior within the designated migration corridor.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of gray whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species. 100% Eastern North Pacific Stock.

Figure 6-59: Gray Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.2.5 Humpback Whales

Impacts have been modeled for the Hawaiian population of humpback whales, which are not Endangered Species Act-Listed, and for the Mexican and Central American populations of humpback whales, which are Endangered Species Act-Listed.

Impacts from Explosives under the Proposed Action for Training Activities

Humpback whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-60 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-56).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The breeding area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the Study Area. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex; however, within the Hawaii Range Complex training with explosives typically occurs only in offshore waters except for some activity near Honolulu. In either case, the training occurs outside the humpback whale breeding area identified by Baird et al. (2015). Humpback whales within the identified breeding area would not be directly exposed to sound or energy from explosions; therefore, impacts on breeding behaviors would not be anticipated within the identified humpback whale breeding area from training with explosives.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of humpback whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Humpback whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-60 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-56Table 6-).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as

described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

The breeding area for humpback whales identified by Baird et al. (2015) overlaps the Hawaii Range Complex within the Study Area. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex; however, within the Hawaii Range Complex testing with explosives typically occurs only in offshore waters except for some activity near Honolulu; in either case, the testing occurs outside the humpback whale breeding area identified by Baird et al. (2015). Humpback whales within the identified breeding area would not be directly exposed to sound or energy; therefore, impacts on breeding behaviors would not be anticipated within the identified humpback whale breeding area from testing with explosives.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of humpback whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species

Figure 6-60: Humpback Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-56: Estimated Impacts on Individual Humpback Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Central America DPS (California, Oregon, & Washington)	4%	10%
Mexico DPS (California, Oregon, & Washington)	35%	8%
Hawaii DPS (Central North Pacific)	62%	82%

6.5.2.3.2.6 Minke Whales

Impacts from Explosives under the Proposed Action for Training Activities

Minke whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-61 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-57).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

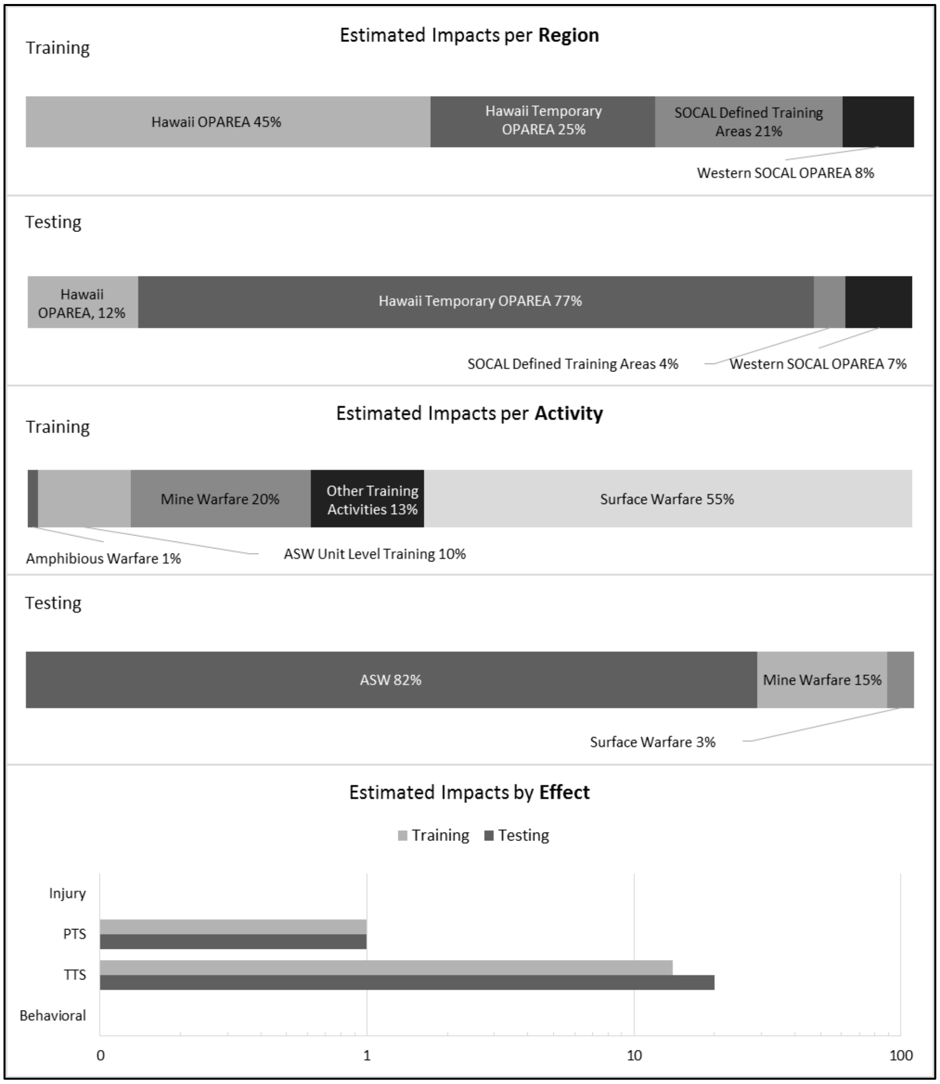
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of minke whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Minke whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-61 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-57).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of minke whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses or injuries (non-auditory) are estimated for this species.

Figure 6-61: Minke Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-57: Estimated Impacts on Individual Minke Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions.

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	29%	11%
Hawaiian	71%	89%

6.5.2.3.2.7 Sei Whales (Endangered Species Act-Listed)

Impacts from Explosives under the Proposed Action for Training Activities

Sei whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-62 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-58).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of sei whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Sei whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-62 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-58).

As described for other mysticetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of sei whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species

Figure 6-62: Sei Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-58: Estimated Impacts on Individual Sei Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions.

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	29%	55%
Eastern North Pacific	71%	45%

6.5.2.3.3 Odontocetes

Odontocetes may be exposed to sound and energy from explosives associated with training and testing activities throughout the year. Explosions produce sounds that are within the hearing range of odontocetes (see Section 6.3, Marine Mammal Hearing and Vocalization). Potential impacts from explosive energy and sound include non-auditory injury, behavioral reactions, physiological stress, masking and hearing loss. Impact ranges for odontocetes exposed to explosive sound and energy are discussed in Section 6.5.2.2 (Impact Ranges for Explosives) under mid-frequency cetaceans for most species, and under high-frequency cetaceans for Kogia whales and Dall's porpoises.

Injuries (non-auditory) to odontocetes, if they did occur, could include anything from mild injuries that are recoverable and are unlikely to have long-term consequences, to more serious injuries, including mortality. It is possible for marine mammals to be injured or killed by an explosion in isolated instances. Mitigation measures discussed in Chapter 11 (Mitigation Measures) prescribe pausing detonations when animals are sighted within, or entering the mitigation zones around an explosion to protect against injuries. Nevertheless, animals that did sustain injury could have long-term consequences for that individual. Considering that dolphin species for which these impacts are predicted have populations with tens to hundreds of thousands of animals, removing several animals from the population would be unlikely to have measurable long-term consequences for the species or stocks.

Odontocetes that do experience a hearing threshold shift from explosive sounds may have reduced ability to detect biologically important sounds (e.g., social vocalizations) until their hearing recovers. Recovery from a hearing threshold shift begins almost immediately after the noise exposure ceases. A threshold shift can take a few minutes to a few days, depending on the severity of the initial shift, to recover. TTS would recover fully and PTS would leave some residual hearing loss. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency.

Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the period that an odontocete had hearing loss, social calls from conspecifics and sounds from predators such as killer whale vocalizations could be more difficult to detect or interpret, although many of these sounds may be above the frequencies of the threshold shift. Odontocetes use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above a few kHz, which are less likely to be affected by threshold shift at lower frequencies, and should not affect odontocete's ability to locate prey or rate of feeding.

Research and observations of masking in marine mammals due to impulsive sounds are discussed in Section 6.5.1.4 (Masking). Explosions introduce low-frequency, broadband sounds into the environment, which could mask hearing thresholds in odontocetes that are nearby, although sounds from explosions last for only a few seconds at most. Also, odontocetes typically communicate, vocalize, and echolocate at higher frequencies that would be less affected by masking noise at lower frequencies such as those produced by an explosion. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for odontocetes in the area over the short duration of the event. Potential costs to odontocetes from masking are similar to those discussed above for TTS, with the primary difference being that the effects

of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Section 6.5.1.5, Behavioral Reactions) show that odontocetes do not typically show strong behavioral reactions to impulsive sounds such as explosions. Reactions, if they did occur, would likely be limited to short ranges, within a few kilometers of multiple explosions. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Animals disturbed while engaged in other activities such as feeding or reproductive behaviors may be more likely to ignore or tolerate the disturbance and continue their natural behavior patterns. Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from odontocetes are likely to be short-term and low to moderate severity.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 6.5.1.3, Physiological Stress. Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosions would not be expected.

6.5.2.3.3.1 Sperm Whales (Endangered Species Act-Listed)

Impacts from Explosives under the Proposed Action for Training Activities

Sperm whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6-63 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-59).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of sperm whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Sperm whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-63 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-59).

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of sperm whales incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species.

Figure 6-63: Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-59: Estimated Impacts on Individual Sperm Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	86%	80%
Hawaiian	14%	20%

6.5.2.3.3.2 Kogia Whales

Kogia whales include two species that are often difficult to distinguish from one another: dwarf sperm whales and pygmy sperm whales.

TTS and PTS thresholds for high-frequency cetaceans, such as Kogia whales are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans).

Impacts from Explosives under the Proposed Action for Training Activities

Kogia whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-64 through Figure 6-66, and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts of dwarf and pygmy sperm whales apply to the Hawaiian stock. Estimated impacts of Kogia whales (not species specific) apply to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for dwarf sperm whales identified by Baird et al. (2015) is within the Hawaii Range Complex. This area occurs off the west coast of the Big Island of Hawaii. The Navy does not generally train with explosives in this area. Dwarf sperm whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosives; therefore, impacts would not be anticipated within the identified dwarf sperm whale small and resident population area from training with explosives.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of dwarf and pygmy sperm whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

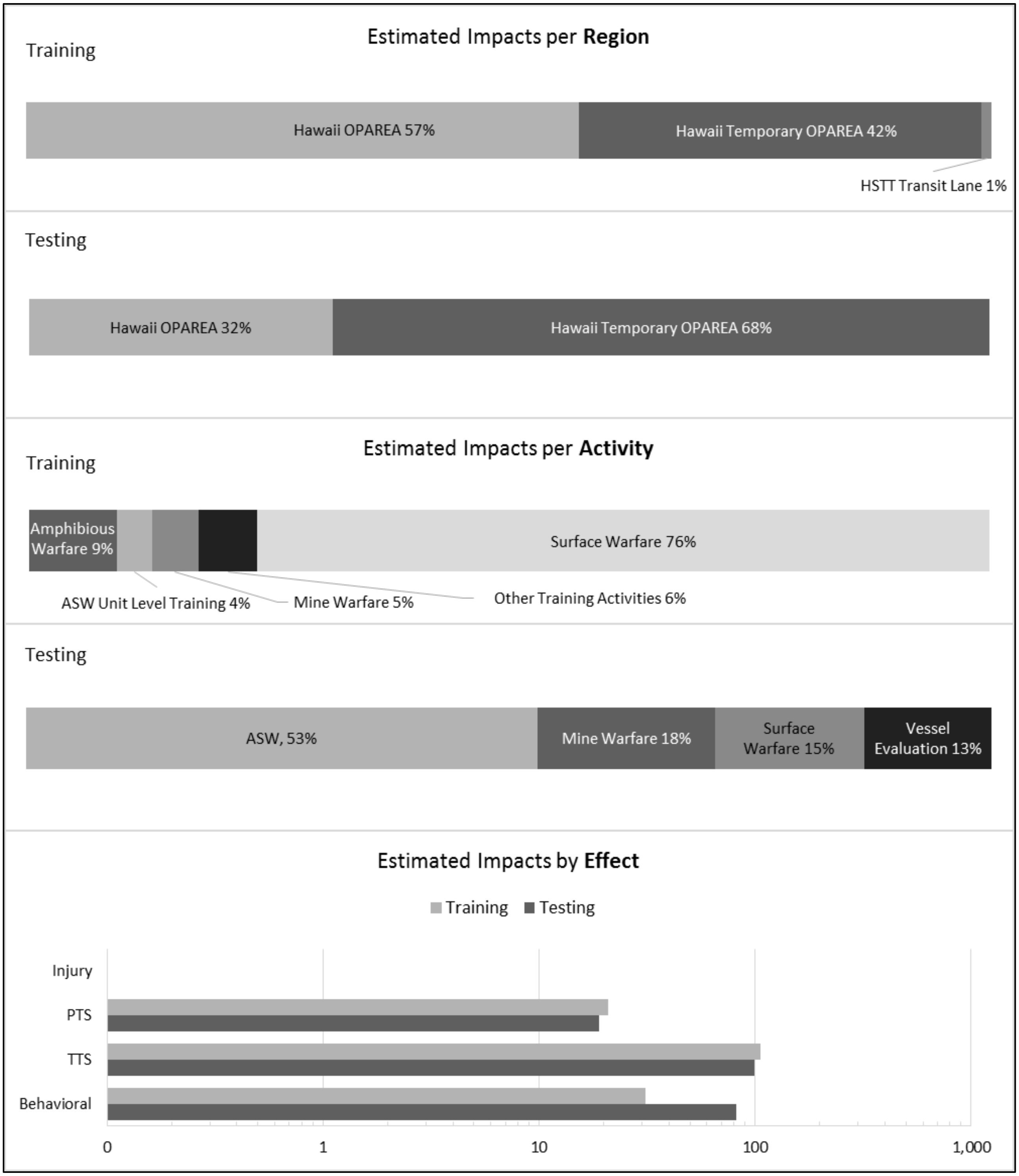
Kogia whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-64 through Figure 6-66, and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts of dwarf and pygmy

sperm whales apply to the Hawaiian stock. Estimated impacts of Kogia whales (not species specific) apply to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

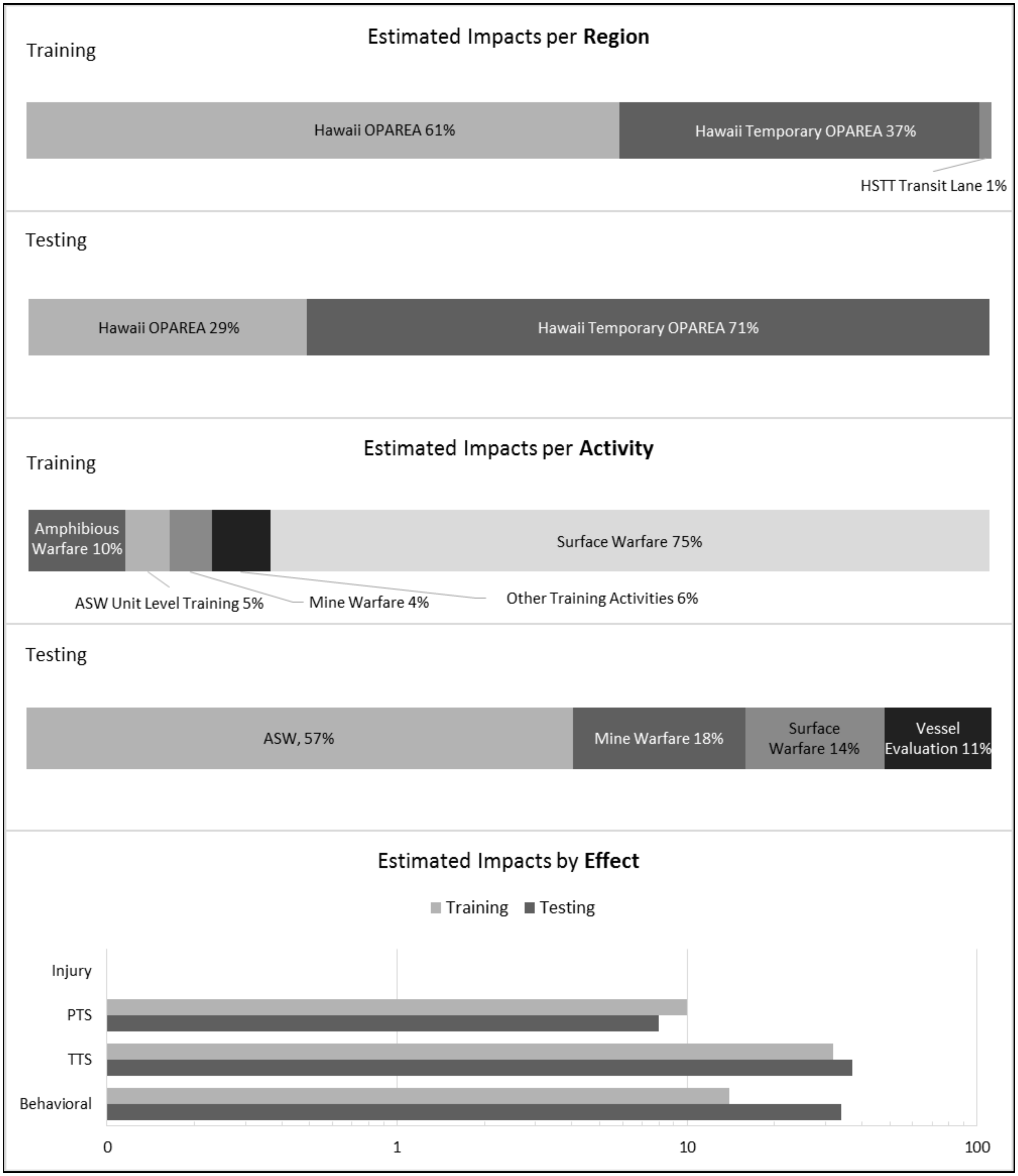
A small and resident population area for dwarf sperm whales identified by Baird et al. (2015) is within the Hawaii Range Complex. This area occurs off the west coast of the Big Island of Hawaii. The Navy does not generally conduct explosive testing in this area. Dwarf sperm whales in the identified small and resident population areas identified by Baird et al. (2015) would not be exposed directly to sound or energy from explosives; therefore, impacts would not be anticipated within the identified dwarf sperm whale small and resident population area from testing with explosives.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of dwarf and pygmy sperm whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-64: Dwarf Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-65: Pygmy Sperm Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% California, Oregon, and Washington Stock.

Figure 6-66: Kogia Whales Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.3 Beaked Whales

Beaked whales within the HSTT study area include: Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, Longman's beaked whale, Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale, and the Pygmy beaked whale. Impacts to Hubb's beaked whale, Ginkgo-toothed beaked whale, Perrin's beaked whale, Stejneger's beaked whale and the Pygmy beaked whale are combined and represented in the beaked whale guild (Mesoplodon spp.).

Research and observations (see Section 6.5.2.1.1.4, Behavioral Responses from Explosives) show that beaked whales are sensitive to human disturbance including noise from sonars, although no research on specific reactions to impulsive or explosion noise is available. Odontocetes overall have shown little responsiveness to impulsive sounds although it is likely that beaked whales are more reactive than most other odontocetes. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. Beaked whales on Navy ranges have been observed leaving the area for a few days during sonar training exercises. It is reasonable to expect that animals may leave an area of more intense explosive activity for a few days, however most explosive use during Navy activities is short-duration consisting of only a single or few closely timed explosions (i.e., detonated within a few minutes) with a limited footprint due to a single detonation point. Because noise from most activities using explosives is short-term and intermittent and because detonations usually occur within a small area, behavioral reactions from beaked whales are likely to be short-term and moderate severity.

Impacts from Explosives under the Proposed Action for Training Activities

Beaked whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS for the beaked whale guild (Medoplodon spp.) (see Figure 6-68 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). No impacts are estimated for Baird's beaked whale, Blainville's beaked whale, and Cuvier's beaked whale. Estimated impacts for the beaked whale guild (Medoplodon spp.) only apply to the California, Oregon, and Washington stock.

As described above, even a few minor to moderate behavioral reactions or TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Hubb's, ginkgo-toothed, Perrin's, Stejneger's, and pygmy beaked whales incidental to those activities.

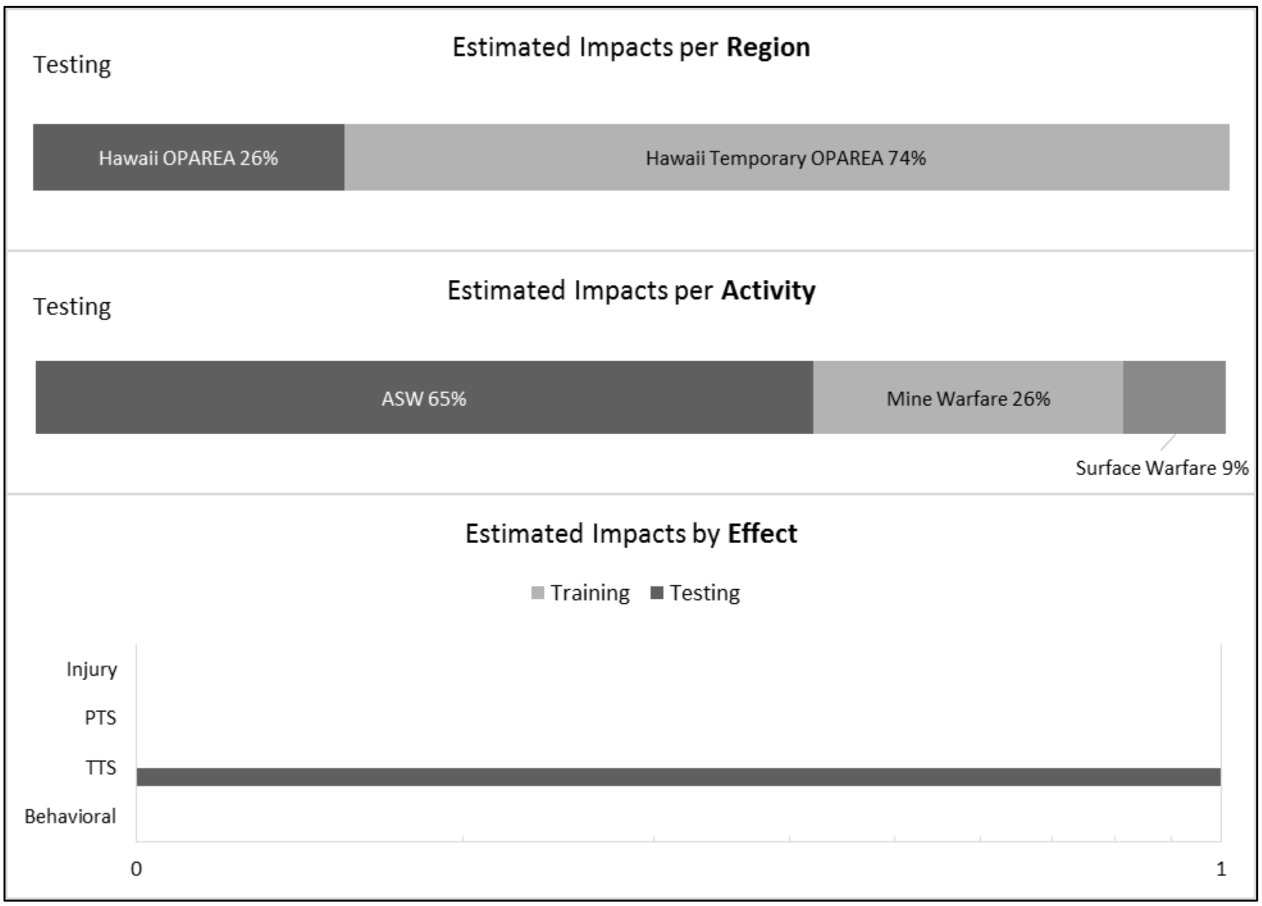
Impacts from Explosives under the Proposed Action for Testing Activities

Beaked whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS for Longman's beaked whale and behavioral reactions and TTS for the beaked whale guild (Medoplodon spp.) (see Figure 6-67 and Figure 6-68 and tabular results

in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). No impacts are estimated for Baird's beaked whale, Blainville's beaked whale, Cuvier's beaked whale, and Longman's beaked whale. Estimated impacts for Longman's beaked whale only apply to the Hawaiian stock. Estimated impacts for the beaked whale guild (Medoplodon spp.) only apply to the California, Oregon, and Washington stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Longman's, Hubb's, ginkgo-toothed, Perrin's, Stejneger's, and Pygmy beaked whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-67: Longman's Beaked Whale Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under the Proposed Action

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species. 100% California, Oregon, and Washington Stock.

Figure 6-68: Mesoplodon Spp. (Beaked Whale Guild) Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.4 Bottlenose Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Bottlenose dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-69 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-60Table 6-).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, bottlenose dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to bottlenose dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of bottlenose dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Bottlenose dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-69 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-60).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Four small and resident population areas for bottlenose dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified bottlenose dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, bottlenose dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to bottlenose dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of bottlenose dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species.

Figure 6-69: Bottlenose Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-60: Estimated Impacts on Individual Bottlenose Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	14%
California Coastal	0%	3%
California, Oregon, and Washington Offshore	55%	78%
Hawaiian Pelagic	2%	3%
Oahu	43%	1%

6.5.2.3.3.5 False Killer Whales

Impacts from Explosives under the Proposed Action for Training Activities

False killer whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-70 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks.

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

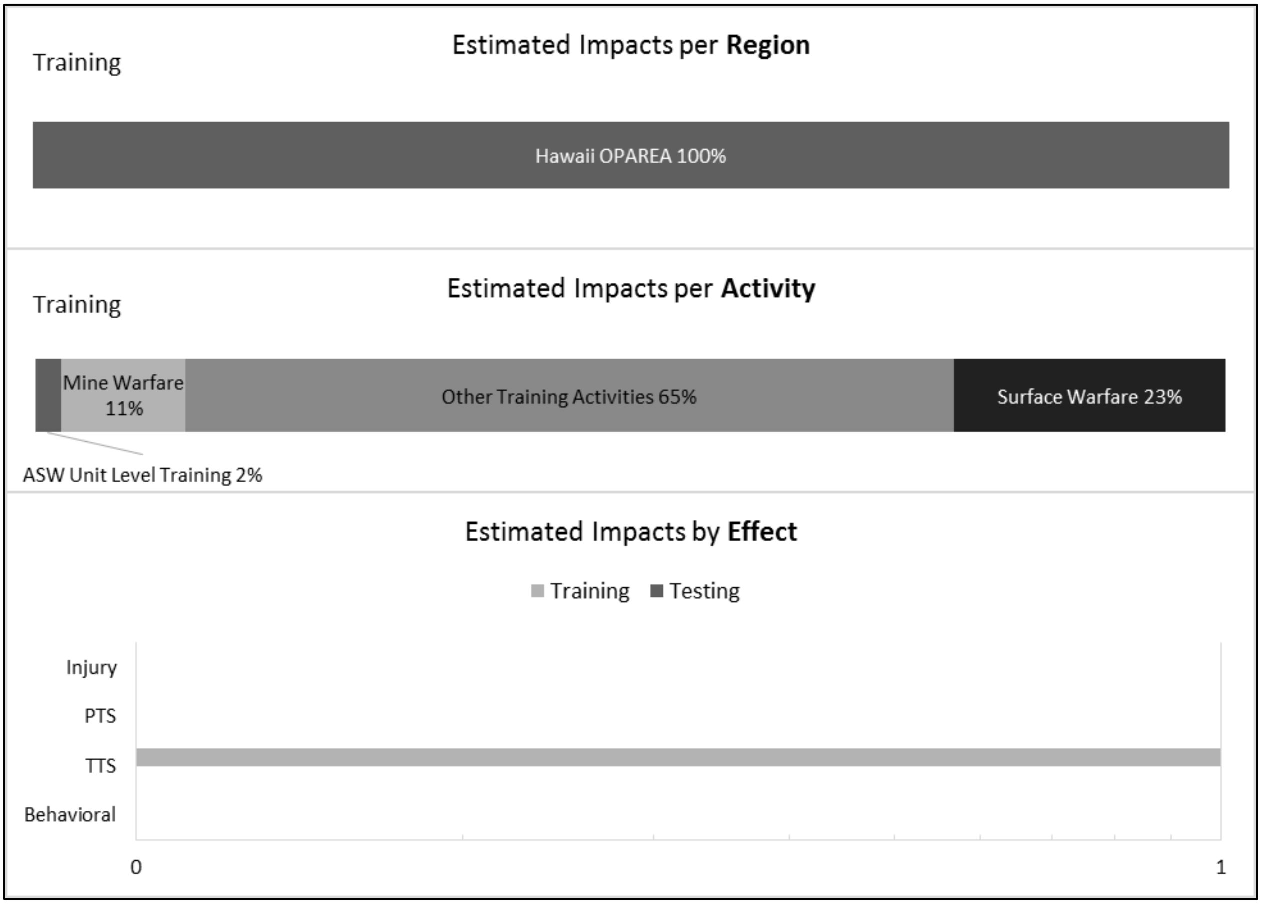
A small and resident population area for false killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within shallow, near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the false killer whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, false killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to false killer whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of false killer whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

False killer whales (main Hawaiian Islands Insular stock is Endangered Species Act Listed) may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no false killer whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will not result in the unintentional taking of false killer whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species.

Figure 6-70: False Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training Under the Proposed Action

6.5.2.3.3.6 Fraser's Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Fraser's dolphin may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reaction, TTS, and PTS (see Figure 6-71 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in S Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

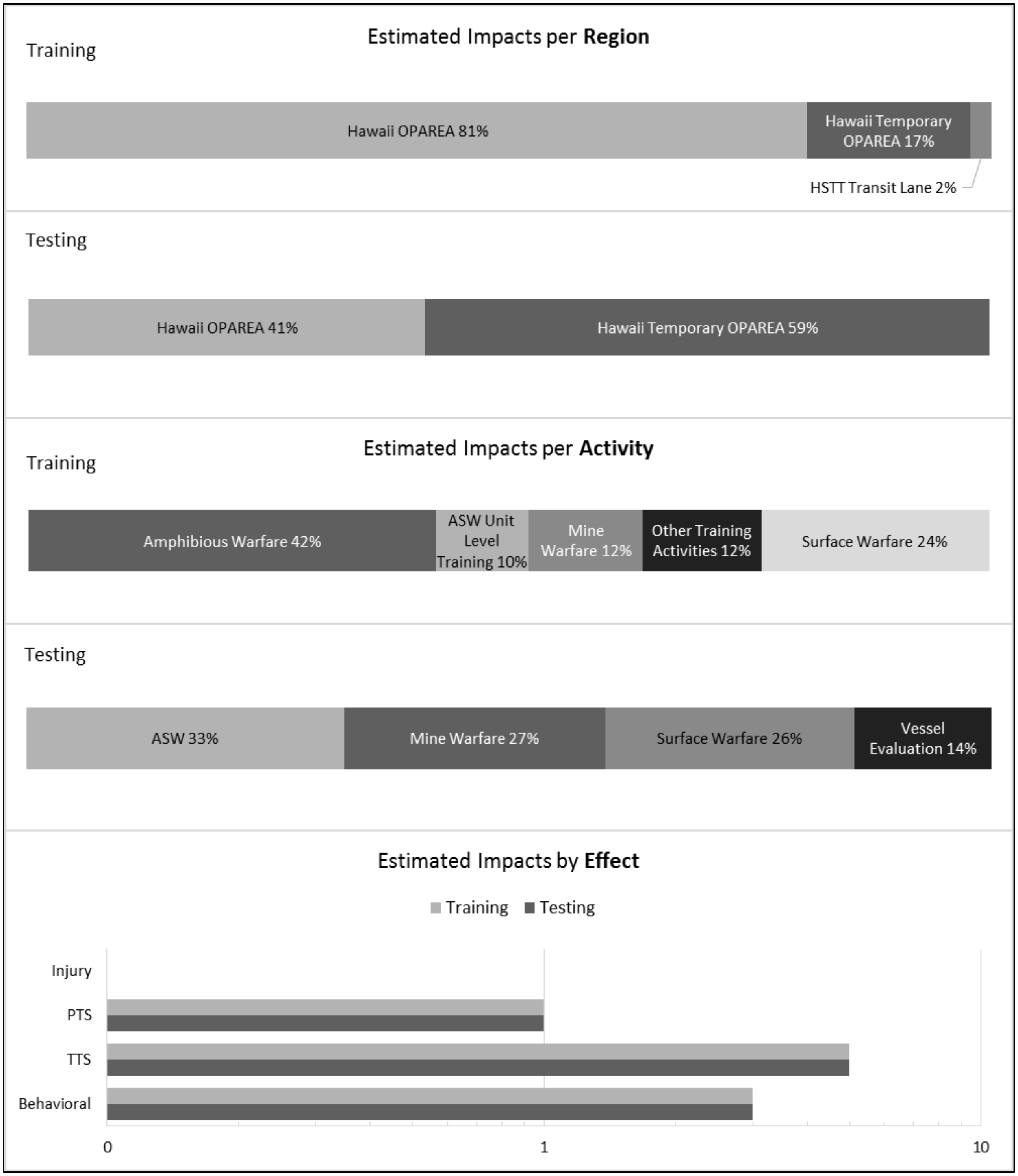
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Fraser's dolphin incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Fraser's dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-71 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in S Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Fraser's dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-71: Fraser's Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.7 Killer Whales

Killer whales may be exposed to sound or energy from explosions associated with training or testing activities throughout the year, although the quantitative analysis estimates that no killer whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training or testing activities as described under the Proposed Action will not result in the unintentional taking of killer whales incidental to those activities.

6.5.2.3.3.8 Long-Beaked Common Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Long-beaked common dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-72 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of long-beaked common dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Long-beaked common dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-72 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens of thousands are unlikely to occur even if an injury created long-term consequences for that individual or

lead to mortality. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of long-beaked common dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100% California Stock.

Figure 6-72: Long-Beaked Common Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.9 Melon-Headed Whales

Impacts from Explosives under the Proposed Action for Training Activities

Melon-headed whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavior reactions and TTS (see Figure 6-73 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian Island stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosions could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, melon-headed whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to melon-headed whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of melon-headed whales incidental to those activities.

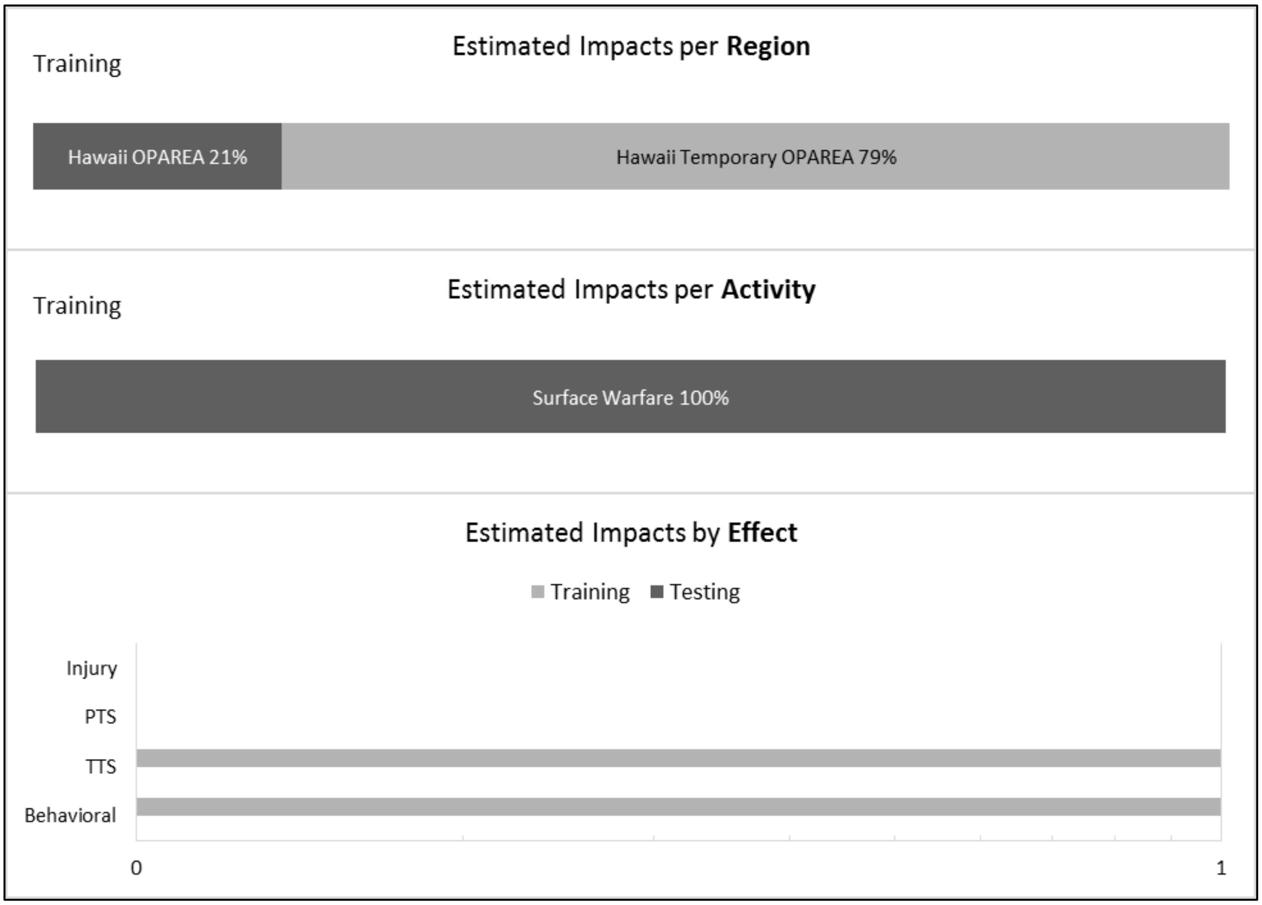
Impacts from Explosives under the Proposed Action for Testing Activities

Melon-headed whales may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no melon-headed whales would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

A small and resident population area for melon-headed whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the melon-headed whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, melon-headed whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to melon-

headed whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will not result in the unintentional taking of melon-headed whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for testing activities. No PTS or injuries (non-auditory) are estimated for this species. 100% Hawaiian Islands Stock.

Figure 6-73: Melon-Headed Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training Under the Proposed Action

6.5.2.3.3.10 Northern Right Whale Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Northern right whale dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-74 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Northern right whale dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Northern right whale dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-74 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Northern right whale dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100% California, Oregon, and Washington Stock.

Figure 6-74: Northern Right Whale Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.11 Pantropical Spotted Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Pantropical spotted dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-75 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-61).

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, pantropical spotted dolphin reactions to explosives are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pantropical spotted dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.

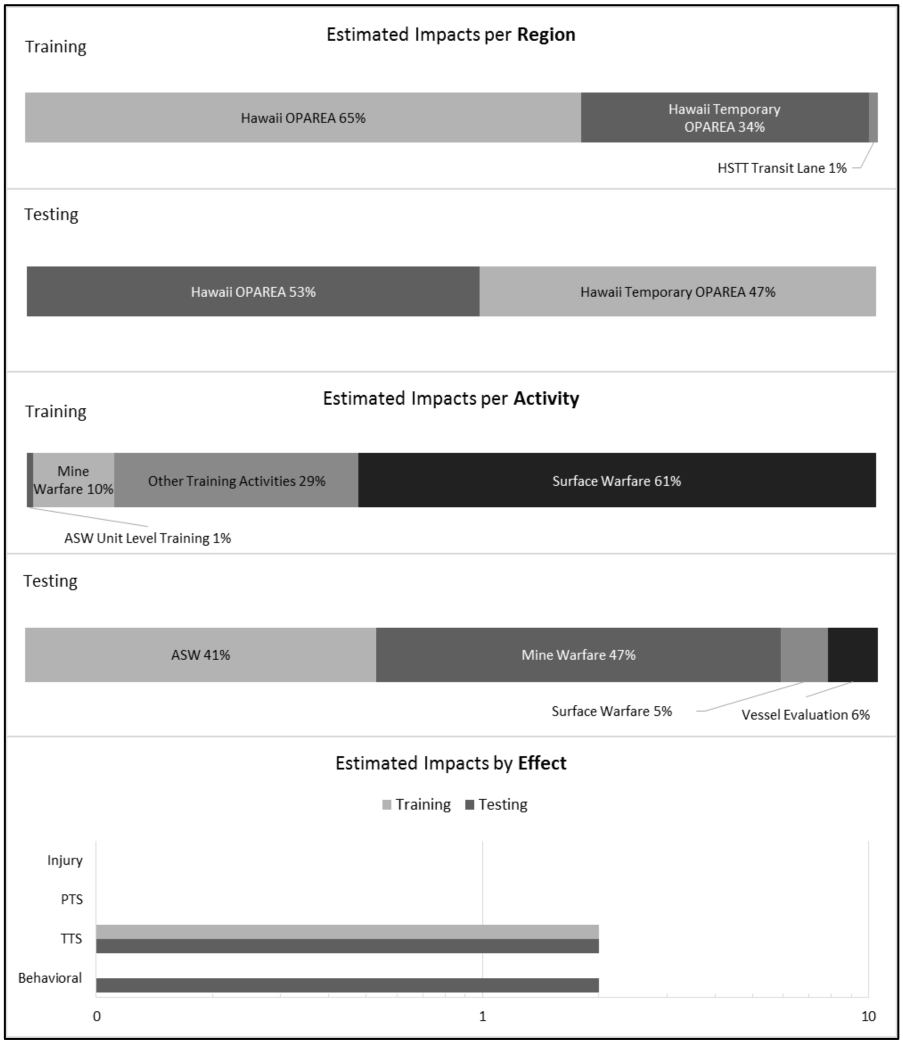
Impacts from Explosives under the Proposed Action for Testing Activities

Pantropical spotted dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6-75 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (seeTable 6- Table-61).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Three small and resident population areas for pantropical spotted dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosions However, sound from explosives could still expose animals within the identified pantropical spotted dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, pantropical spotted dolphin reactions to explosives are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pantropical spotted dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of pantropical spotted dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No PTS or injuries (non-auditory) are estimated for this species.

Figure 6-75: Pantropical Spotted Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-61: Estimated Impacts on Individual Pantropical Spotted Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
4-Island	0%	50%
Oahu	47%	1%
Hawaii Pelagic	39%	39%
Hawaii Island	14%	9%

6.5.2.3.3.12 Pacific White-Sided Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Pacific white-sided dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-76and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

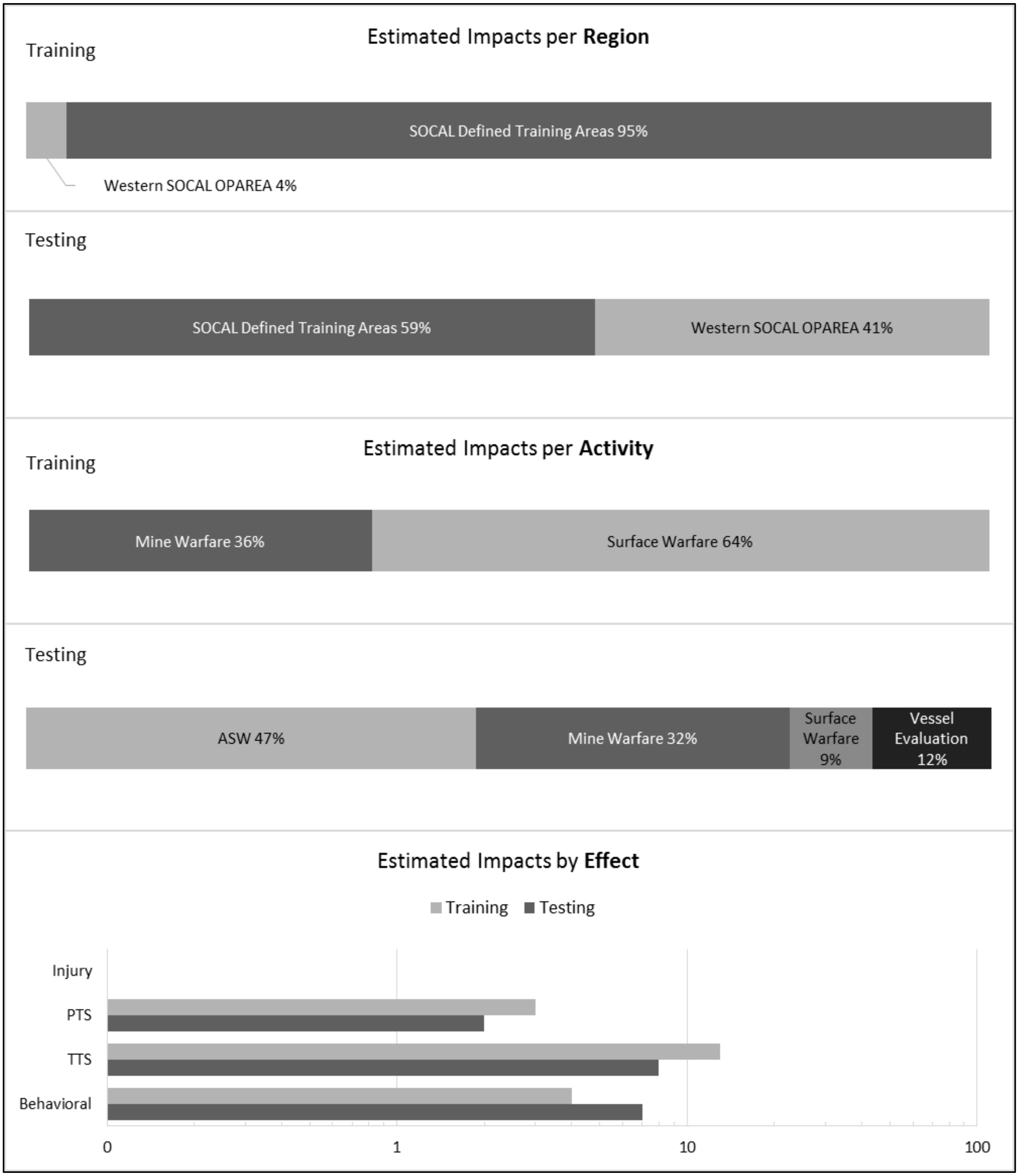
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Pacific white-sided dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-76 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Pacific white-sided dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% California, Oregon, and Washington Stock.

Figure 6-76: Pacific White-Sided Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.13 Pygmy Killer Whales

Impacts from Explosives under the Proposed Action for Training Activities

Pygmy killer whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-77 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (See Table 6-62).

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, pygmy killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pygmy killer whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of pygmy killer whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

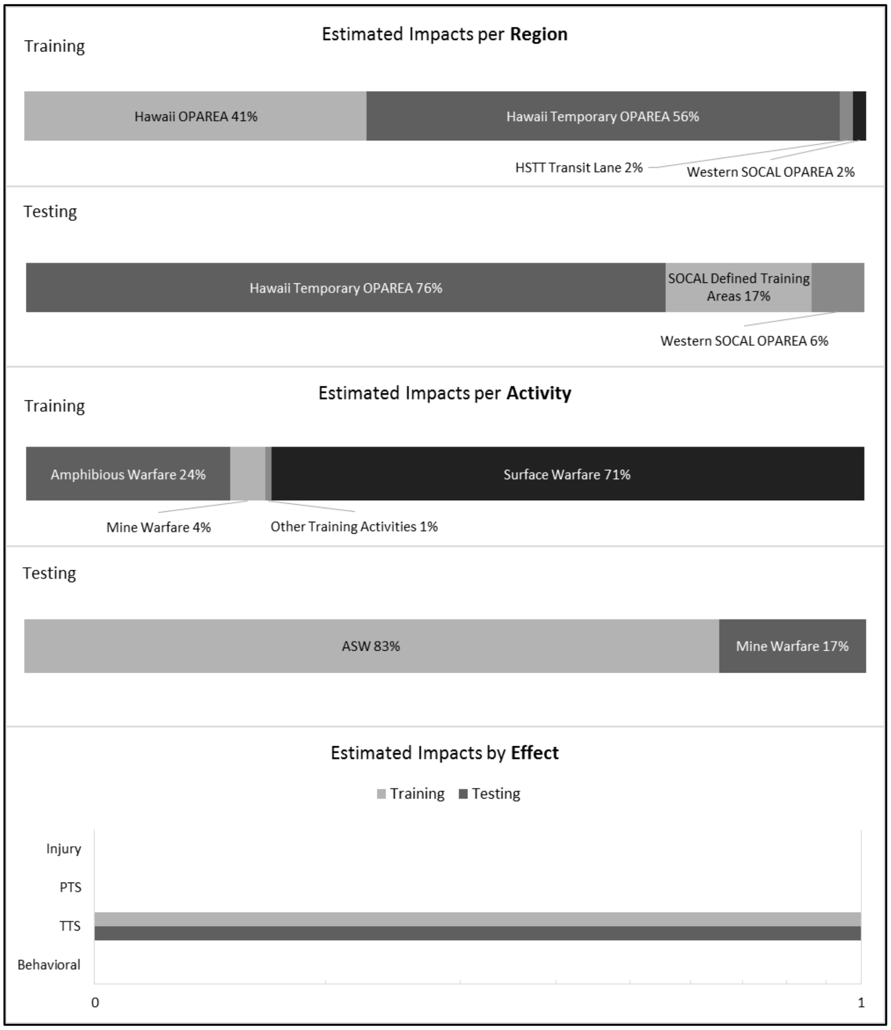
Pygmy killer whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS (see Figure 6-77 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described for odontocetes above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for pygmy killer whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that

involve explosives. However, sound from explosives could still expose animals within the pygmy killer whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, pygmy killer whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to pygmy killer whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of pygmy killer whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No behavioral responses, PTS, or injuries (non-auditory) are estimated for this species.

Figure 6-77: Pygmy Killer Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-62: Estimated Impacts on Individual Pygmy Killer Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	98%	76%
Tropical	2%	24%

6.5.2.3.3.14 Risso's Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Risso's dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-78 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 5-63).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Risso's dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Risso's dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-78 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-63).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Risso's dolphins incidental to those activities.Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species.

Figure 6-78: Risso's Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-63: Estimated Impacts on Individual Risso's Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	2%	5%
California, Oregon, & Washington	98%	95%

6.5.2.3.3.15 Rough-Toothed Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Rough-toothed dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year, although the quantitative analysis estimates that no rough-toothed dolphins would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, explosive use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from explosives could expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, rough-toothed dolphin reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to rough-toothed dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will not result in the unintentional taking of rough-toothed dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

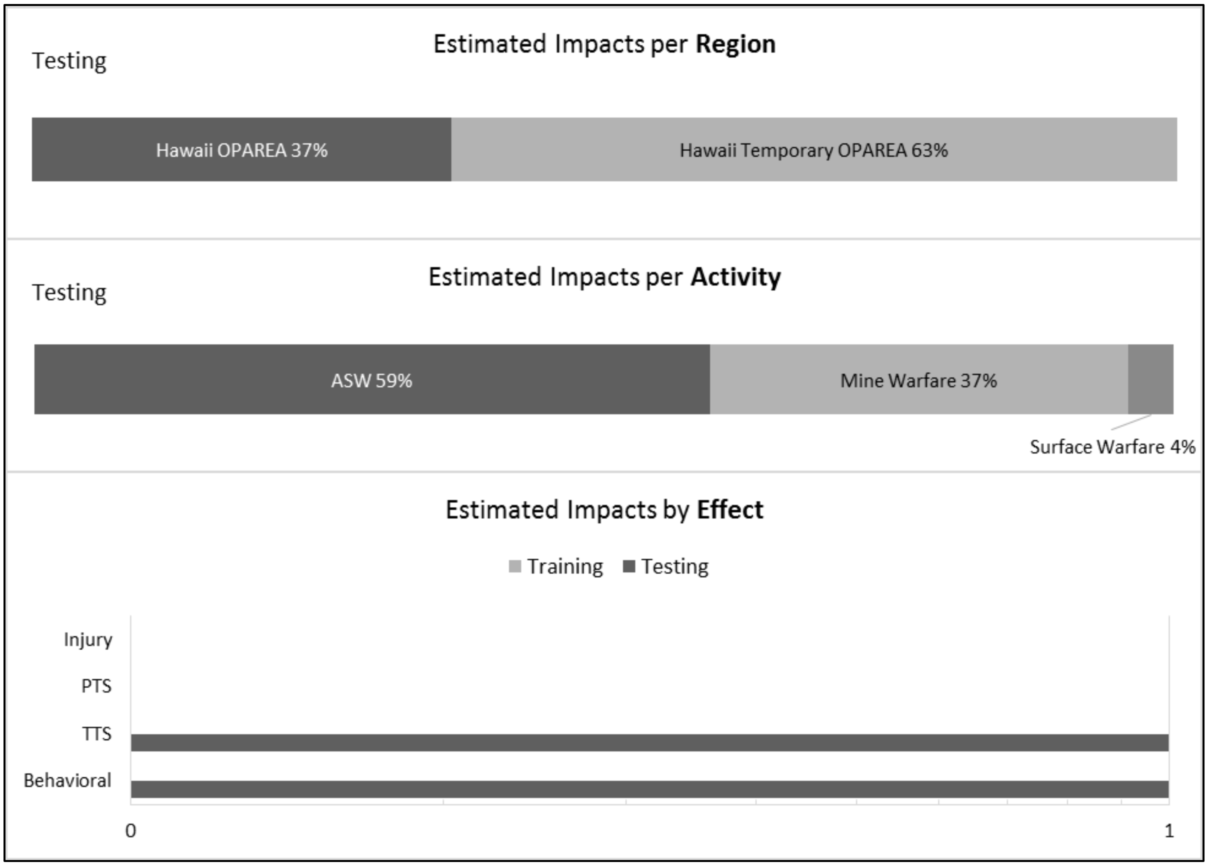
Rough-toothed dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6-79 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for rough-toothed dolphins identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area only takes up a very small portion Range Complex; therefore, explosive use in this area would be infrequent and typically only last for a short duration if it did occur. The sound from explosives could expose animals within the identified rough-toothed dolphin small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, rough-toothed dolphin reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important

biological behaviors. Therefore, significant impacts to rough-toothed dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of rough-toothed dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No PTS or injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-79: Rough-Toothed Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Testing Under the Proposed Action

6.5.2.3.3.16 Short-Beaked Common Dolphin

Impacts from Explosives under the Proposed Action for Training Activities

Short-beaked common dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-80 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). In addition, the quantitative analysis estimates one mortality for short-beaked common dolphin from training activities. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury or mortality created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of short-beaked common dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Short-beaked common dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-80 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). In addition, the quantitative analysis estimates one mortality for short-beaked common dolphin from testing activities. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury or mortality created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of short-beaked common dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100% California, Oregon, and Washington Stock.

Figure 6-80: Short-Beaked Common Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.3.17 Short-Finned Pilot Whales

Impacts from Explosives under the Proposed Action for Training Activities

Short-finned pilot whales may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-81 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6- 6-64).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, short-finned pilot whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to short-finned pilot whale natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of short-finned pilot whales incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

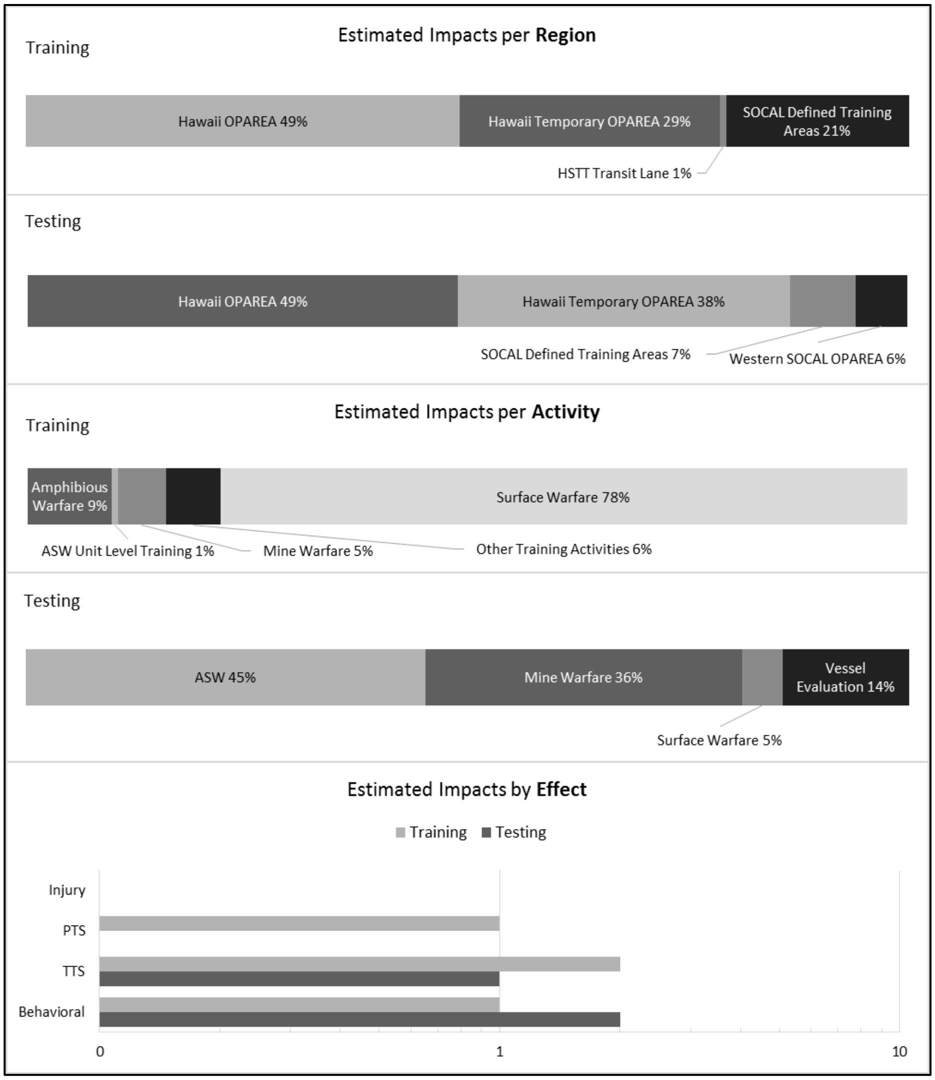
Short-finned pilot whales may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6-81 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-64Table 6-).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as

described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

A small and resident population area for short-finned pilot whales identified by Baird et al. (2015) is within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. This identified small and resident population area is mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the short-finned pilot whale small and resident population area identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, short-finned pilot whale reactions to sound are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to short-finned pilot whale natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population area identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of short-finned pilot whales incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare

Figure 6-81: **Short-Finned Pilot Whale Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action**

Table 6-64: Estimated Impacts on Individual Short-Finned Pilot Whale Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaiian	79%	87%
California, Oregon, & Washington	21%	13%

6.5.2.3.3.18 Spinner Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Spinner dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-82 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (seeTable 6- Table 6-65).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy training activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, spinner dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to spinner dolphin natural behaviors or abandonment due to training with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of spinner dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Spinner dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions and TTS (see Figure 6-82 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (seeTable 6- Table 6-65).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as

described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Five small and resident population areas for spinner dolphins identified by Baird et al. (2015) are within the Hawaii Range Complex year-round. Navy testing activities that use explosives could occur year-round within the Hawaii Range Complex. The identified small and resident population areas are mostly located within near-shore waters where the Navy does not typically conduct activities that involve explosives. However, sound from explosives could still expose animals within the identified spinner dolphin small and resident population areas identified by Baird et al. (2015) and some impacts to behavior could occur. As discussed above, spinner dolphin reactions to sounds are most likely short-term and mild to moderate, especially when sound sources are located more than a few kilometers away or when the animals are engaged in important biological behaviors. Therefore, significant impacts to spinner dolphin natural behaviors or abandonment due to testing with explosives are unlikely to occur within the small and resident population areas identified by Baird et al. (2015).

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of spinner dolphins incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species.

Figure 6-82: Spinner Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-65: Estimated Impacts on Individual Spinner Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
Hawaii Pelagic	5%	19%
Hawaii Island	0%	2%
Oahu and 4-Island	95%	79%

6.5.2.3.3.19 Striped Dolphins

Impacts from Explosives under the Proposed Action for Training Activities

Striped dolphins may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-83 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-66)

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

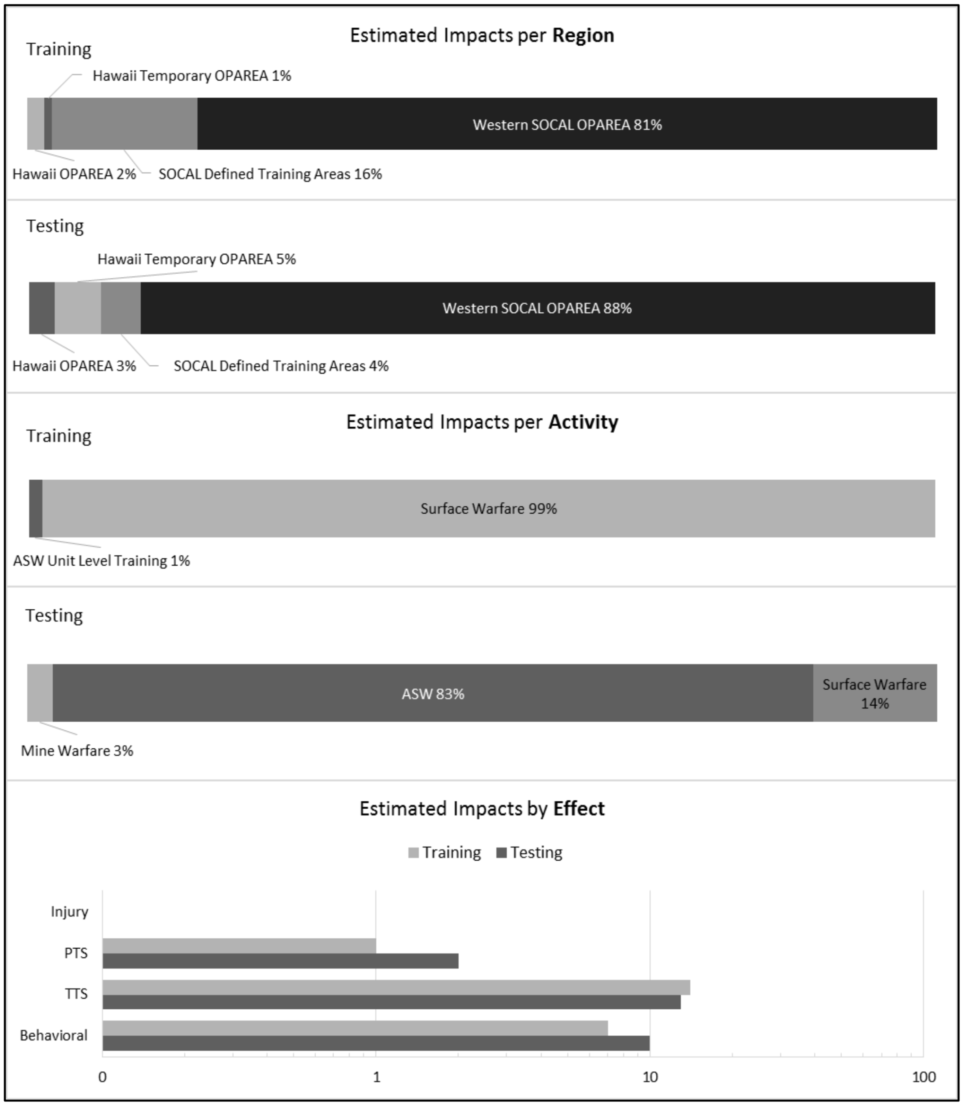
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of striped dolphins incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Striped dolphins may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions TTS and PTS (see Figure 6-83 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply to multiple stocks (see Table 6-66).

As described for odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of striped dolphins incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. ASW: Anti-Submarine Warfare

Figure 6-83: Striped Dolphin Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

Table 6-66: Estimated Impacts on Individual Striped Dolphin Stocks Within the Study Area per Year from Training and Testing Explosions Using the Maximum Number of Explosions

Estimated Impacts per **Species' Stock**		
Stock	***Training***	***Testing***
California, Oregon, and Washington	97%	92%
Hawaiian	3%	8%

6.5.2.3.3.20 Dall's Porpoises

TTS and PTS thresholds for high-frequency cetaceans, such as Dall's porpoises, are lower than for all other marine mammals, which leads to a higher number of estimated hearing loss impacts relative to the number of animals exposed to the sound as compared to other hearing groups (e.g., mid-frequency cetaceans). During the period that a Dall's porpoise had hearing loss, vocalizations from conspecifics could be more difficult to detect or interpret, however Dall's porpoises vocalize at frequencies above 100 kHz which is likely to be well above the frequency of threshold shift induced by sound from an explosion. Odontocetes, including the Dall's porpoise, use echolocation clicks to find and capture prey. These echolocation clicks and vocalizations are at frequencies above 100 kHz for Dall's porpoises and are therefore unlikely to be affected by threshold shift at lower frequencies. This should not affect Dall's porpoise's ability to locate prey or rate of feeding.

Research and observations (see Section 6.5.2.1.1.4, Behavioral Responses from Explosives) show that harbor porpoises, a closely related species to Dall's porpoises, are sensitive to human disturbance including noise from impulsive sources. Observations of harbor porpoises near seismic surveys using air guns and pile driving operations show animals avoiding by 5–20 km, but returning quickly to the area after activities cease. Reactions could include alerting, startling, breaking off feeding dives and surfacing, diving or swimming away, change in vocalization, or showing no response at all. It is reasonable to expect that animals may leave an area of more intense explosive activity, but return within a few days, however most explosive use during Navy activities is short-duration consisting of only a single or few closely timed explosions with a limited footprint due to a single detonation point. Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from Dall's porpoises are likely to be short-term and moderate severity.

A few TTS or behavioral reactions in an individual animal within a given year are unlikely to result in any long-term consequences. PTS could reduce an animal's ability to detect biologically important sounds; however, as discussed above, a small threshold shift due to low frequency sound from an explosion is unlikely to affect the hearing range that Dall's porpoises rely upon. Nevertheless, PTS could have minor long-term consequences for individuals. This minor consequence for an individual is unlikely to have any long-term consequences for the species or stocks.

<u>Impacts from Explosives under the Proposed Action for Training Activities</u>

Dall's porpoises may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions TTS, and PTS (see Figure 6-84 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as

described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Dall's porpoises incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Dall's porpoises may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions TTS, and PTS (see Figure 6-84 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California, Oregon, and Washington stock.

As described for other odontocetes above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Dall's porpoises incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% California, Oregon, and Washington Stock.

Figure 6-84: Dall's Porpoise Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.4 Pinnipeds

Pinnipeds include phocid seals (true seals) and otariids (sea lions and fur seals).

Pinnipeds that do experience TTS from explosive sounds may have reduced ability to detect biologically important sounds until their hearing recovers. Recovery from TTS begins almost immediately after the noise exposure ceases and can take a few minutes to a few days, depending on the severity of the initial shift, to fully recover. Threshold shifts do not necessarily affect all hearing frequencies equally, and typically manifest themselves at the exposure frequency or within an octave above the exposure frequency. Noise from explosions is broadband with most energy below a few hundred Hertz; therefore, any hearing loss from exposure to explosive sounds is likely to be broadband with effects predominantly at lower frequencies. During the short period that a pinniped had TTS, social calls from conspecifics could be more difficult to detect or interpret, however most pinniped vocalizations may be above the frequency of TTS induced by an explosion. Killer whales are one of the pinniped primary predators. Killer whale vocalizations are typically above a few kHz, well above the region of hearing that is likely to be affected by exposure to explosive energy. Therefore, TTS in pinnipeds due to sound from explosions is unlikely to reduce detection of killer whale calls. Pinnipeds may use sound underwater to find prey and feed; therefore, a TTS could have a minor and temporary effect on a phocid seal's ability to locate prey.

Research and observations of auditory masking in marine mammals due to impulsive sounds are discussed in Section 6.5.1.4 (Masking). Explosions introduce low frequency, broadband sounds into the environment, which could mask hearing thresholds in pinnipeds that are nearby, although sounds from explosions last for only a few seconds at most. Masking due to time-isolated detonations would not be significant. Activities that have multiple detonations such as some naval gunfire exercises could create some masking for pinnipeds in the area over the short duration of the event. Potential costs to pinnipeds from masking are similar to those discussed above for TTS, with the primary difference being that the effects of masking are only present when the sound from the explosion is present within the water and the effect is over the moment the sound has ceased.

Research and observations (see Section 6.5.1.5, Behavioral Reactions) show that pinnipeds may be the least sensitive taxonomic group to most noise sources. They are likely to only respond to loud impulsive sound sources at close ranges by startling, jumping into the water when hauled out, or even cease foraging, but only for brief periods before returning to their previous behavior. Pinnipeds may even experience TTS before exhibiting a behavioral response (Southall et al., 2007). Because noise from most activities using explosives is short-term and intermittent, and because detonations usually occur within a small area, behavioral reactions from phocid seals are likely to be short-term and low severity.

Physiological stress could be caused by injury or hearing loss and could accompany any behavioral reaction as well. Research and observations of physiological stress in marine mammals are discussed in Section 6.5.1.3, Physiological Stress. Due to the short-term and intermittent use of explosives, physiological stress is also likely to be short-term and intermittent. Long-term consequences from physiological stress due to the sound of explosives would not be expected.

6.5.2.3.4.1 Guadalupe Fur Seals (Endangered Species Act-listed)

Impacts from Explosives under the Proposed Action for Training Activities

Guadalupe fur seals (Mexico stock is Endangered Species Act Listed) may be exposed to sound or energy from explosions associated with training activities throughout the year, although the quantitative analysis estimates that no Guadalupe fur seals would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will not result in the unintentional taking of Guadalupe fur seals incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Guadalupe fur seals (Mexico stock is Endangered Species Act Listed) may be exposed to sound or energy from explosions associated with testing activities throughout the year, although the quantitative analysis estimates that no Guadalupe fur seals would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will not result in the unintentional taking of Guadalupe fur seals incidental to those activities.

6.5.2.3.4.2 Hawaiian Monk Seals (Endangered Species Act-listed)

Impacts from Explosives under the Proposed Action for Training Activities

Hawaiian monk seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates TTS and PTS (see Figure 6-85 and tabular results in Section 5.1). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described above, even a few minor to moderate TTS to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of Hawaiian monk seals incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Hawaiian monk seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action behavioral reactions and TTS (see Figure 6-85 and tabular results in Section 5.1). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the Hawaiian stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Hawaiian monk seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% Hawaiian Stock.

Figure 6-85: Hawaiian Monk Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.4.3 Harbor Seals

Impacts from Explosives under the Proposed Action for Training Activities

Harbor seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-86 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of harbor seals incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Harbor seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-86 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of harbor seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No injuries (non-auditory) are estimated for this species. 100% California Stock.

Figure 6-86: Harbor Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.4.4 Northern Elephant Seals

Impacts from Explosives under the Proposed Action for Training Activities

Northern elephant seals may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS and injury (non-auditory) (see Figure 6-87 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of northern elephant seals incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Northern elephant seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS and PTS (see Figure 6-87 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for these species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives).

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Northern elephant seals incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100% California Stock.

Figure 6-87: Northern Elephant Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.4.5 California Sea Lions

Impacts from Explosives under the Proposed Action for Training Activities

California sea lions may be exposed to sound or energy from explosions associated with training activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-88 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). In addition, the quantitative analysis estimates one mortality for California sea lions from training activities. Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the U.S. stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury or mortality created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of California sea lions incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

California sea lions may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, PTS, and (non-auditory) injury (see Figure 6-88 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the U.S. stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Long-term consequences for a population numbering in the tens or hundreds of thousands are unlikely to occur even if an injury created long-term consequences for that individual. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking California sea lions incidental to those activities.

Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. 100% U.S. Stock.

Figure 6-88: California Sea Lion Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.5.2.3.4.6 Northern Fur Seals

Impacts from Explosives under the Proposed Action for Training Activities

Northern fur seals may be exposed to sound or energy from explosions associated with training activities throughout the year, although the quantitative analysis estimates that no northern fur seals would be impacted. Long-term consequences for individuals, the species, or stock would not be expected.

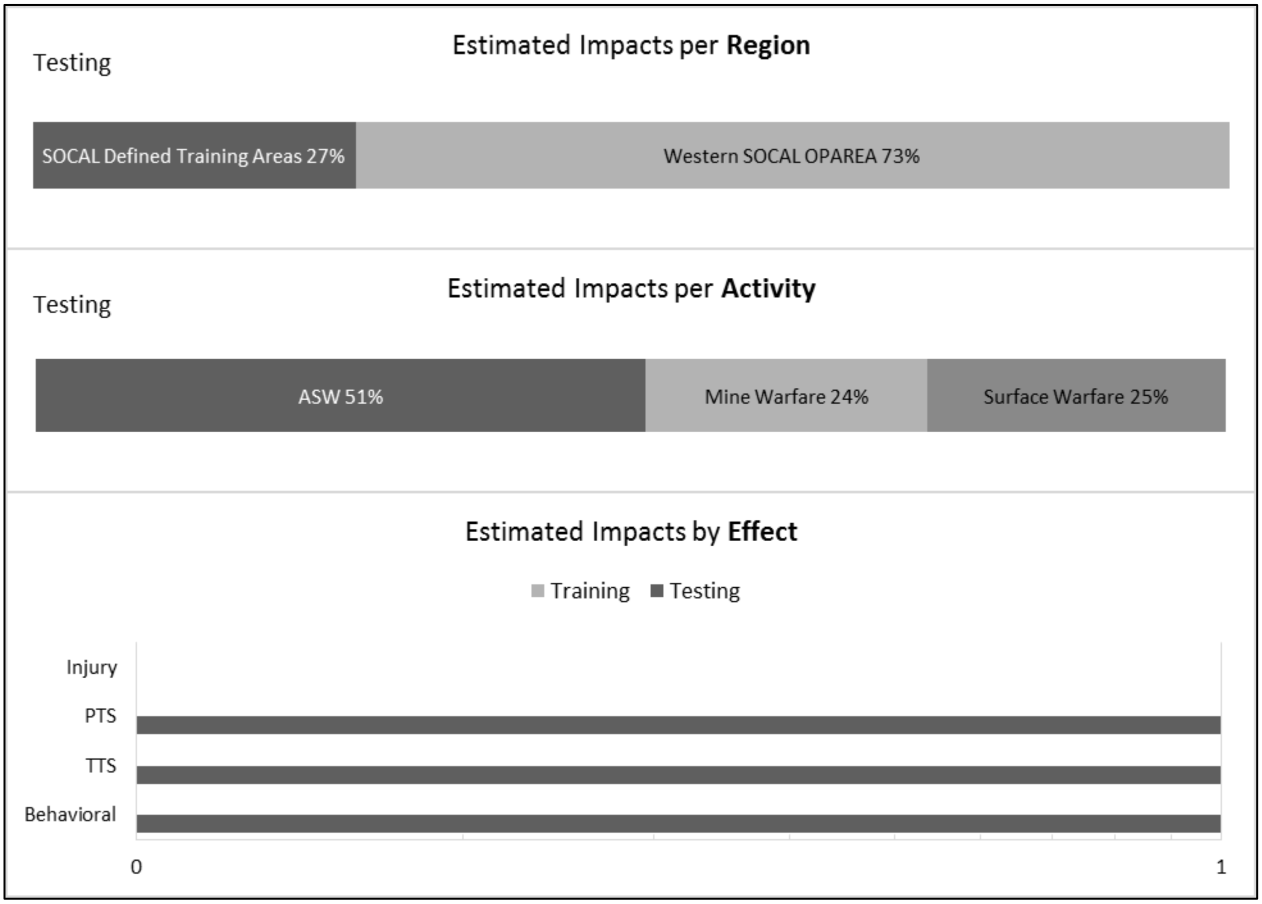
Pursuant to the MMPA, the use of explosives during training activities as described under the Proposed Action will result in the unintentional taking of northern fur seals incidental to those activities.

Impacts from Explosives under the Proposed Action for Testing Activities

Northern fur seals may be exposed to sound or energy from explosions associated with testing activities throughout the year. The quantitative analysis, using the maximum number of explosions per year under the Proposed Action, estimates behavioral reactions, TTS, and PTS (see Figure 6-89 and tabular results in Section 5.1, Incidental Take Request from Acoustic and Explosive Sources). Estimated impacts most years would be less based on fewer explosions. Impact ranges for this species are discussed in Section 6.5.2.2 (Impact Ranges for Explosives). Estimated impacts apply only to the California stock.

As described above, even a few minor to moderate TTS or behavioral reactions to an individual over the course of a year are unlikely to have any significant costs or long-term consequences for that individual. PTS in an individual could have no to minor long-term consequences for individuals although a single minor long-term consequence for an individual is unlikely to lead to long-term consequences for a population. Considering these factors and the mitigation measures that would be conducted as described in Chapter 11 (Mitigation Measures), long-term consequences for the species or stock would not be expected.

Pursuant to the MMPA, the use of explosives during testing activities as described under the Proposed Action will result in the unintentional taking of Northern fur seals incidental to those activities.



Region and Activity bar charts show categories +/- 0.5 percent of the estimated impacts. Estimated impacts most years would be less based on fewer explosions. No impacts are estimated for training activities. No injuries (non-auditory) are estimated for this species. 100% California Stock.

Figure 6-89: Northern Fur Seal Impacts Estimated per Year from the Maximum Number of Explosions During Training and Testing Under the Proposed Action

6.6 ESTIMATED TAKE OF MARINE MAMMALS BY VESSEL STRIKE

6.6.1 BACKGROUND ON VESSEL STRIKES

Vessel strikes from commercial, recreational, and Navy vessels are known to have resulted in serious injury and occasional fatalities to cetaceans (Abramson et al., 2011; Berman-Kowalewski et al., 2010; Calambokidis, 2012; Laggner, 2009; Lammers et al., 2003; Van der Hoop et al., 2012; Van der Hoop et al., 2013; Van der Hoop et al., 2015). Reviews of the literature on ship strikes mainly involve collisions between commercial vessels and whales (e.g., Jensen and Silber (2003); Laist et al. (2001)).

Vessel speed, size, and mass are all important factors in determining potential impacts of a vessel strike to marine mammals (Conn & Silber, 2013; Gende et al., 2011; Silber et al., 2010; Vanderlaan & Taggart, 2007; Wiley et al., 2016). For large vessels, speed and angle of approach can influence the severity of a strike. Based on modeling, Silber et al. (2010) found that whales at the surface experienced impacts that increased in magnitude with the ship's increasing speed. Results of the study also indicated that potential impacts were not dependent on the whale's orientation to the path of the ship, but that vessel speed may be an important factor. At ship speeds of 15 knots or higher, there was a marked increase in intensity of centerline impacts on whales. Results also indicated that when the whale was below the surface (about one to two times the vessel draft), there was a pronounced propeller suction effect. This suction effect may draw the whale into the hull of the ship, increasing the probability of propeller strikes (Silber et al., 2010).

In the HSTT Study Area, comparison of commercial vessel traffic with Navy vessel traffic over a 1-year period showed that Navy surface ships accounted for 97,000 hours of accumulated at-sea time whereas commercial shipping accounted for 875,000 hours (Mintz, 2012). Therefore, Navy ship activity represented only 11 percent of all vessel hours within the HSTT Study Area, but it should be noted that Navy vessels in the Pacific often stop or move slowly at sea depending on mission requirements and fuel saving mandates. Navy vessels, given they are much fewer in number, are a small component of overall vessel traffic in most areas where they operate and this is especially the case in the HSTT Study Area (National Marine Fisheries Service, 2015b).

Navy ships transit at speeds that are optimal for fuel conservation or to meet operational requirements. Small craft (for purposes of this discussion, less than 18 m in length), which are all support craft, have much more variable speeds (0–50+ knots, dependent on the mission). Submarines generally operate at speeds in the range of 8–13 knots. While these speeds are considered averages and representative of most events, some vessels need to operate outside of these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier engaged in flight operations must adjust its speed through the water accordingly. Also, there are other instances such as launch and recovery of a small rigid hull inflatable boat; vessel boarding, search, and seizure training events; or retrieval of a target when vessels would be dead in the water or moving slowly ahead to maintain steerage. There are a few specific events, including high-speed tests of newly constructed vessels, where vessels would operate at higher speeds.

Large Navy vessels (greater than 18 m in length) within the offshore areas of the HSTT Study Area operate differently from commercial vessels in ways important to the prevention of whale collisions. For example, the average speed of large Navy ships ranges between 10 and 15 knots. By comparison, this is slower than most commercial vessels where full speed for a container ship is typically 24 knots (Bonney & Leach, 2010). Even given the advent of "slow steaming" by commercial vessels in recent years due to

fuel prices (Barnard, 2016; Maloni et al., 2013), this is generally a reduction of only a few knots, given 21 knots would be considered slow, 18 knots is defined as extra slow, and 15 knots is considered super slow (Bonney & Leach, 2010).

The ability to detect a marine mammal and avoid a collision depends on a variety of factors, including environmental conditions, ship design, size, speed, and manning, as well as the behavior of the animal. Differences between most Navy ships and commercial ships also include the following:

- The Navy has several standard operating procedures for vessel safety that could result in a secondary benefit to marine mammals through a reduction in the potential for vessel strike, as discussed in Section 1.5.5 (Standard Operating Procedures). For example, ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. A primary duty of watch personnel is to ensure safety of the ship, and this includes the requirement to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship as a standard collision avoidance procedure. Navy vessels operate in accordance with the navigation rules established by the U.S. Coast Guard. All vessels operating on the water are required to follow the International Navigation Rules (COMDTINST M16672.2D). These rules require that vessels at all times proceed at a safe speed so that proper and effective action can be taken to avoid collision and so they can be stopped within a distance appropriate to the prevailing circumstances and conditions.
- Many Navy ships have their bridges positioned closer to the bow, offering good visibility ahead of the ship.
- There are often aircraft associated with the Navy's training or testing activity, which can detect marine mammals in the vicinity or ahead of a vessel's present course.
- Navy ships are generally much more maneuverable than commercial merchant vessels if marine mammals are spotted and the need to change direction is necessary.
- Navy ships operate at the slowest speed possible consistent with either transit needs or training or testing needs. While minimum speed is intended as a fuel conservation measure particular to a certain ship class, secondary benefits include better ability to spot and avoid objects in the water, including marine mammals.
- In many cases, Navy ships will likely move randomly or with a specific pattern within a sub-area of the Study Area for a period of time from 1 day to 2 weeks as compared to straight line point-to-point commercial shipping.
- Navy overall crew size, including bridge crew, is much larger than merchant ships allowing for more potential watch personnel on the bridge.
- When submerged, submarines are generally slow moving (to avoid detection) and therefore marine mammals at depth with a submarine are likely able to avoid collision with the

submarine. When a submarine is transiting on the surface, there are Lookouts serving the same function as they do on surface ships.

- The Navy will implement mitigation to avoid potential impacts from vessel strikes on marine mammals (see Chapter 11, Mitigation Measures). Mitigation includes training Lookouts and watch personnel with the Marine Species Awareness Training (which provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures), and requiring vessels to maneuver to maintain a specified distance from marine mammals during vessel movements.
- The Navy uses the Protective Measures Assessment Protocol software tool, which provides operators with notification of the required mitigation and a visual display of the planned training or testing activity location overlaid with relevant environmental data.

6.6.1.1 Mysticetes

Vessel strikes have been documented for almost all of the mysticete species (Van der Hoop et al., 2012; Van der Hoop et al., 2013; Van der Hoop et al., 2015). This includes blue whales (Berman-Kowalewski et al., 2010; Calambokidis, 2012; Van Waerebeek et al., 2007), fin whales (Douglas et al., 2008; Van Waerebeek et al., 2007), sei whales (Felix & Van Waerebeek, 2005; Van Waerebeek et al., 2007), Bryde's whales (Felix & Van Waerebeek, 2005; Van Waerebeek et al., 2007), minke whales (Van Waerebeek et al., 2007), and humpback whales (Bradford & Lyman, 2015; Douglas et al., 2008; Lammers et al., 2003; Van Waerebeek et al., 2007).

Research suggests that the increasing noise in the ocean has made it difficult for whales to detect approaching vessels, which has indirectly raised the risk of vessel strike (Elvin & Taggart, 2008). For example, right whales are documented to show little overall reaction to the playback of sounds of approaching vessels, suggesting that some whales perform only a last-second flight response (Nowacek et al., 2004). McKenna et al. (2015) documented limited blue whale reactions in the form of short-term shallow dive avoidance responses to large commercial vessels in heavily used commercial shipping lanes in Southern California. Some individuals may become habituated to low-frequency sounds from shipping and fail to respond to an approaching vessel (National Marine Fisheries Service, 2008). Because surface activity includes feeding, breeding, and resting, whales may be engaged in this activity and not notice an approaching vessel (Silber et al., 2010). On the other hand, the lack of an acoustic cue of vessel presence can be detrimental as well. One study documented multiple cases where humpback whales struck anchored or drifting vessels; in one case a humpback whale punched a 1.5 meter hole through the hull of an anchored 22 m wooden sailboat, and another instance a humpback whale rammed a powered down 10 m fiberglass sailboat (Neilson et al., 2012). These results suggest that either the whales did not detect the vessel, or they intentionally struck it. In this study, vessel strikes to multiple cetacean species were included in the investigation; however, humpback whales were the only species that displayed this type of interaction with an unpowered vessel. Wiley et al. (2016) reported on two North Atlantic right whales that were struck by small research vessels. Another study found that 79 percent of reported collisions between sailing vessels and cetaceans occurred when the vessels were under sail, suggesting it may be difficult for whales to detect the faint sound of sailing vessels (Ritter, 2012).

Generally, mysticetes are larger than odontocetes and are not able to maneuver as well as odontocetes to avoid vessels. In addition, mysticetes do not typically aggregate in large groups and are therefore difficult to visually detect from the water surface. Mysticetes that occur within the HSTT Study Area

have varying patterns of occurrence and distribution which overlap with areas where vessel use associated with Navy training and testing activities would occur.

6.6.1.2 Odontocetes

In general, odontocetes move quickly and seem to be less vulnerable to vessel strikes than other cetaceans; however, most small whale and dolphin species have at least occasionally suffered from vessel strikes including: killer whale (Van Waerebeek et al., 2007; Visser & Fertl, 2000), short-finned and long-finned pilot whales (Aguilar et al., 2000; Van Waerebeek et al., 2007), bottlenose dolphin (Bloom & Jager, 1994; Van Waerebeek et al., 2007; Wells & Scott, 1997), white-beaked dolphin (Van Waerebeek et al., 2007), short-beaked common dolphin (Van Waerebeek et al., 2007), spinner dolphin (Camargo & Bellini, 2007; Van Waerebeek et al., 2007), striped dolphin (Van Waerebeek et al., 2007), Atlantic spotted dolphin (Van Waerebeek et al., 2007), and pygmy sperm whales (*Kogia breviceps*) (Van Waerebeek et al., 2007). Beaked whales documented in vessel strikes include: Arnoux's beaked whale (Van Waerebeek et al., 2007), Cuvier's beaked whale (Aguilar et al., 2000; Van Waerebeek et al., 2007), and several species of Mesoplodon (Van Waerebeek et al., 2007). However, evidence suggests that beaked whales may be able to hear the low-frequency sounds of large vessels and thus avoid collision (Ketten, 1998). Sperm whales may be exceptionally vulnerable to vessel strikes as they spend extended periods of time "rafting" at the surface in order to restore oxygen levels within their tissues after deep dives (Jaquet & Whitehead, 1996; Watkins et al., 1999). Overall, collision avoidance success is dependent on a marine mammal's ability to identify and locate the vessel from its radiated sound and the animal's ability to maneuver away from the vessel in time. Based on hearing capabilities and dive behavior, sperm whales may not be capable of successfully completing an escape maneuver, such as a dive, in the time available after perceiving a fast-moving vessel. This supports the suggestion that vessel speed is a critical parameter for sperm whale collision risks (Gannier & Marty, 2015).

Odontocetes that occur within the HSTT Study Area have varying patterns of occurrence and distribution which overlap with areas where vessel use associated with Navy training and testing activities would occur. Available literature suggests based on their smaller body size, maneuverability, larger group sizes, and hearing capabilities, most odontocetes (with the exception of sperm whales) are not as likely to be struck by a Navy vessel as mysticetes. When generally compared to mysticetes, odontocetes are more capable of physically avoiding a vessel strike and since some species occur in large groups, they are more easily seen when they are closer to the water surface.

6.6.1.3 Pinnipeds

As noted previously, vessels have a potential to cause behavioral disturbance to pinnipeds. The variability observed are related to the context of the situation and by the animal's experience (Ellison et al., 2011; Richardson et al., 1995; Southall et al., 2007). Reactions include a wide spectrum of effects from avoidance and alert, to cases where animals in the water are attracted, and cases on land where there is lack of significant reaction suggesting habituation to or tolerance of vessels (Richardson et al., 1995). Physical disturbance to hauled out harbor seals caused by approaching cruise ships (Blundell & Pendleton, 2015; Jansen et al., 2015; Young et al., 2014) and by the presence of powerboats and kayaks that stopped, lingered, or moved slowly along haul-out sites (Johnson & Acevedo-Gutiérrez, 2007) have been documented. Given that Navy vessels do not purposefully approach pinnipeds on land, it is unlikely that Navy training and testing involving vessels would result in disturbance to pinnipeds on land. At sea, Navy vessel presence may result in minor and insignificant changes in behavior. NMFS has previously determined that the rarity of ship strikes involving pinnipeds combined with the Navy's established standard operating procedures and mitigations leads to the assumption that the exposure risk of

collision from surface vessels or submarines in the HSTT Study Area is small enough to be discountable (National Oceanic and Atmospheric Administration, 2015b). There has been no new science since that time which suggests a need to change that determination.

Ship strikes were not reported as a global threat to pinniped populations by Kovacs et al. (2012). Pinnipeds in general appear to suffer fewer impacts from ship strikes than do cetaceans. This may be due, at least in part, to the large amount of time they spend on land (especially when resting and breeding), and their high maneuverability in the water. Ship strikes are not a major concern for pinnipeds in general, for the threatened Guadalupe fur seal, or for the endangered Hawaiian monk seal (Antonelis et al., 2006; Marine Mammal Commission, 2002; National Marine Fisheries Service, 2007a, 2010a, 2014a). Physical disturbance and strike to pinnipeds as a result of large vessels used during Navy training and testing activities is most likely an insignificant risk to individuals and populations of pinnipeds. Reported sources of human-related injury and mortality for the U.S. west coast from 2010 to 2014, documented 11 California sea lions, 15 harbor seals, and 2 northern elephant seals having injuries caused by boat propellers or small boat collisions (Carretta et al., 2014b). Mortalities of pinnipeds (specifically harbor seals and gray seals) initially hypothesized to be injuries from ducted propellers have been found to be caused by gray seal predation, cannibalism, and infanticide (Brownlow et al., 2016).

6.6.2 PROBABILITY OF VESSEL STRIKE OF LARGE WHALE SPECIES

Most reported vessel strikes of marine mammals involve commercial vessels and occur over or near the continental shelf (Laist et al., 2001). It is Navy policy to report all marine mammal strikes by Navy vessels. The information is collected by Office of the Chief of Naval Operations Environmental Readiness and provided to NMFS on an annual basis. Only Navy and the U.S. Coast Guard reliably report in this manner. Therefore, it should be noted that Navy vessel strikes reported in the scientific literature and NMFS databases are the result of the Navy's commitment to reporting all strikes to NMFS rather than a greater frequency of collisions relative to other ship types (e.g. commercial cargo vessels). Vessel strike to marine mammals is not associated with any specific training or testing activity but rather a limited, sporadic, and incidental result of vessel movement within the Study Area.

Between 2007 and 2009, the Navy developed and distributed additional training, mitigation, and reporting tools to Navy operators to improve marine mammal protection and to ensure compliance with upcoming permit requirements. In 2007, the Navy implemented the Marine Species Awareness Training, which is designed to improve the effectiveness of visual observations for marine resources, including marine mammals and sea turtles. In subsequent years, the Navy issued refined policy guidance regarding marine mammal incidents (e.g., ship strikes) in order to collect the most accurate and detailed data possible in response to a possible incident. For over a decade, the Navy has implemented the Protective Measures Assessment Protocol software tool, which provides operators with notification of the required mitigation and a visual display of the planned training or testing activity location overlaid with relevant environmental data.

Similar mitigation, reporting, and monitoring requirements have been in place since 2009 and are expected to continue into the future. Therefore, the conditions affecting the potential for ship strikes are the most consistent across this time frame. As a result, data from the past nine years (i.e., 2009 to 2016) are used to calculate the probability of a Navy vessel striking a whale during proposed training and testing activities in the Study Area. The level of vessel use and the manner in which the Navy trains and tests in the future (2019–2023) is expected to be consistent with this time period.

The period from 2009 to 2016 was used as the most appropriate time frame from which to calculate the potential probability of a large whale ship strike from Navy vessels in HSTT over the term of anticipated HSTT permit (2019-2023). 2009 represents the beginning of programmatic permitting within the Atlantic and Pacific; acknowledges advances in Navy marine species awareness training and overall enhanced sensitivity to marine resource issues in general; represents the codification of multiple marine species mitigation measures including specific measures to avoid large whales by 500 yards so long as it is safe for navigation; and finally is more representative of current and reasonably foreseeable marine mammal occurrence in HSTT. In addition, 2009 represents a 10 year horizon, which is consistent with the fact that NMFS doesn't consider information older than eight years old in regional stock assessment reports

Data over a period from 2009 to 2016 are used to calculate the most current probability of a Navy vessel striking a whale in the Study Area. From January 2009 through December 2016, a total of two (2) reported whale strikes have occurred from Navy training and testing activities in the HSTT Study Area, two in the Southern California Range Complex (both fin whales in 2009).

Large unmanned surface vehicles are an emerging technology area. Within the timeframe covered by this analysis, the Navy anticipates that testing of large unmanned surface vehicles in the HSTT Study Area would occur up to approximately 300 at-sea days per year. During some testing of large unmanned surface vehicles, the platforms would be manned by testing personnel who would serve as Lookouts and would have the ability to override autonomous navigation; however, other testing would occur while the platform is unmanned. Autonomous marine mammal detection technologies are being investigated, but it is assumed that these technologies may not be available for large unmanned surface vehicle testing in the timeframe covered by this analysis.

Unlike for manned naval vessels, there are no historical at-sea hours or strike data upon which a large unmanned surface vehicle strike analysis can be based. The method presented above for naval vessels, therefore, is followed to assess the risk of strike due to the addition of large unmanned surface vehicle at-sea days. Following the method presented above, an additional 300 at-sea days annually are added to the strike risk to account for large unmanned surface vehicles. This is a small increase in risk compared to the risk based on historical data for manned vessels; however, actual additional risk is assumed to be greater because of the lack of both lookouts and implementation of procedural mitigation. Still, this increased risk would be limited because large unmanned surface vehicle at-sea days are a small portion (less than 7 percent) of overall vessel predicted at-sea days for 2019-2023; large unmanned surface vehicles would be substantially smaller than most naval vessels; and a portion of large unmanned surface vehicle tests would include lookouts who could implement avoidance mitigation.

Since the probability of a Navy vessel strike to whales is influenced by the amount of time at sea for Navy vessels within the HSTT Study Area, the Navy used historical at-sea days in HSTT from 2009–2016 and estimated potential at-sea days for the period from 2019 to 2023. The at-sea days then are used to calculate a strike rate based on the 2009–2016 reporting period. Ship at-sea time for this period totaled 33,860 days. Dividing the two reported strikes by ship at-sea day (2/33,860) results in a strike rate of 0.00006 strike per day. Estimated ship at-sea days within HSTT for the period from 2019 to 2023 is 22,663 days. The historic strike rate (0.00006 strike per day) can be multiplied by the estimated at-sea days from 2019 to 2023 to estimate the number of whale strikes that could be anticipated (0.00006 strike per day x 22,663 days). This calculation predicts up to 1.34 strikes over the period from 2019 to 2023.

The probabilities of a specific number of strikes (n=0, 1, 2, etc.) over the period from 2019 to 2023 can be derived from a Poisson distribution. A Poisson distribution is often used to describe random occurrences when the probability of an occurrence is small, e.g., count data such as cetacean sighting data, or in this case strike data, often described as a Poisson or over-dispersed Poisson distribution. The formula for a Poisson distribution is:

$$P\left\langle n \middle| \mu \right\rangle = \frac{e^{-\mu} \bullet \mu^{n}}{n!}$$

P(n/μ) is the probability of observing n events in some time interval, when the expected number of events in that time interval is μ. For this analysis, $\underline{\mu}$ is the estimated 2019–2023 strike rate of 1.2.

From the strike rate (1.2), the Poisson distribution can estimate the probability of *n* where n=0 (no strikes), 1 strike, 2 strikes, and 3 strikes:

P(0)= 0.262 or a 26% chance of zero strikes over the period from 2019 to 2023
P(1)= 0.351 or a 35% chance of one strike over the period from 2019 to 2023
P(2)= 0.235 or a 23% chance of two strikes over the period from 2019 to 2023
P(3)= 0.105 or a 10% chance of three strikes over the period from 2019 to 2023

Based on the resulting probabilities presented in this analysis, the cumulative low history of Navy vessel strikes from 2009-2016, and the decrease in strike incidents (zero since 2009) by the Navy since introduction of the Marine Species Awareness Training and adaptation of additional mitigation measures since 2009, the Navy does not anticipate vessel strikes to marine mammals within the HSTT Study Area during training and testing activities.

As cautionary acknowledgments that some probability of ship strike, although low, could occur over a five year authorization, and that there are no historical data specific to large unmanned surface vehicles upon which risk of strike can be precisely assessed, the Navy is electing to request a small number of takes to select large whale stocks from vessel strikes for HSTT (section 5.2).

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7 Anticipated Impact of the Activity

Consideration of negligible impact to the species or stock is required for NMFS to authorize incidental take of marine mammals. An activity has a 'negligible impact' on a species or stock when the activity cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

The Navy concludes that training and testing activities proposed in the Study Area would result in Level B and Level A takes, as summarized in Section 5.1 (Incidental Take Request from Acoustic and Explosive Sources) and Section 5. 2 (Incidental Take Request from Vessel Strikes) Based on best available science, the Navy concludes that exposures of marine mammal species and stocks associated with proposed training and testing activities would result in only short-term effects on most individual animals exposed and would not affect annual rates of recruitment or survival for the following reasons:

- Most acoustic and explosive exposures are within the non-injurious temporary threshold shift or behavioral effects zones (Level B harassment).
- Although the numbers presented in Section 6.6 (Summary of All Estimated Numbers and Species Taken by Acoustic and Explosive Sources) represent estimated harassment under the MMPA, they are conservative estimates (i.e., overpredictions) of harassment, primarily by behavioral disturbance.
- The mitigation measures described in Chapter 11 (Mitigation Measures) are designed to avoid or reduce the potential for injury from acoustic, explosive, and physical disturbance stressors to the maximum extent practicable.
- Range complexes where intensive training and testing have been occurring for decades have populations of multiple species with strong site fidelity (including resident beaked whales at some locations) and increases in the number of some species.

This request for LOAs assumes that short-term non-injurious sound exposure levels predicted to cause onset-TTS or temporary behavioral disruptions (non-TTS) qualify as Level B harassment. While many of these exposures would likely not rise to the level of the National Defense Authorization Act definition of Level B harassment, the Navy has no mechanism to quantify actual Level B harassment. The assumption that exposures predicted to cause behavioral disruptions would qualify as Level B harassment results in an overestimate of reactions qualifying as harassment under MMPA because there is no definitive level of exposure to acoustic energy associated with short-term sonar use, underwater detonations, and pile driving/removal which clearly results in long-term abandonment or significant alteration of behavioral patterns in marine mammals.

Long-term Consequences to Species and Stocks

A sound-producing activity can cause a variety of behavioral reactions in animals ranging from very minor and brief, to more severe reactions such as aggression or prolonged flight (Southall et al., 2007). The acoustic stimuli can cause a stress reaction (e.g., startle or annoyance); they may act as a cue to an animal that has experienced a stress reaction in the past to similar sounds or activities, or that acquired a learned behavioral response to the sounds from conspecifics. An animal may choose to deal with these stimuli or ignore them based on the severity of the stress response, the animal's past experience with the sound, and the other stimuli that are present in the environment. If an animal chooses to react to

the acoustic stimuli, then the behavioral responses fall into two categories: alteration of natural behavior patterns and avoidance. The specific type and severity of these reactions helps determine the costs and ultimate consequences to the individual and population.

The potential costs to a marine mammal from an involuntary or behavioral response include no measurable cost, expended energy reserves, increased stress, reduced social contact, missed opportunities to secure resources or mates, displacement, and stranding or severe evasive behavior (which may potentially lead to secondary trauma or death). Animals suffer costs on a daily basis from a host of natural situations such as dealing with predator or competitor pressure. If the costs to the animal from an acoustic-related activity fall outside of its normal daily variations, then individuals must recover from significant costs to avoid long-term consequences. Level B harassment would occur if an animal's natural behavioral patterns were abandoned or significantly altered.

The potential long-term consequences from behavioral responses are difficult to discern. Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their typical normal behaviors. This is likely to depend upon the severity of the reaction and how often the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some animals may habituate to the new baseline; conversely, species that are more sensitive may not return, or return but not resume use of the habitat in the same manner. For example, an animal may return to an area to feed but no longer rest in that area. Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Frequent disruptions to natural behavior patterns may not allow an animal to recover between exposures, which increase the probability of causing long-term consequences to individuals.

Animals that recover quickly and completely are unlikely to suffer reductions in their health or reproductive success, or experience changes in habitat utilization. No population-level effects would be expected if individual animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization. Any long-term consequences to the individual can potentially lead to consequences for the population, although population dynamics and abundance play a role in determining how many individuals would need to experience long-term consequences before there was an effect on the population. Abundant or stable populations that suffer consequences on a few individuals may not be affected overall.

The Context of Behavioral Disruption and TTS–Biological Significance to Populations

The exposure estimates calculated by predictive models currently available reliably predict propagation of sound and received levels and measure a short-term, immediate response of an individual using applicable criteria. Consequences to populations are much more difficult to predict and empirical measurement of population effects from anthropogenic stressors is limited (King et al., 2015; National Research Council, 2005). However, recent research concludes that it is feasible to implement monitoring that assesses the chain of potential relations from initiation of a human activity to population dynamics—from physical and behavioral responses to the activity, to shifts in health, to changes in vital rates (Fleishman et al., 2016). To predict indirect, long-term, and cumulative effects, the processes must be well understood and the underlying data available for models. In response to the National Research Council review (2005), the Office of Naval Research founded a working group to formalize the Population Consequences of Acoustic Disturbance framework. In addition, Navy-funded efforts and other research efforts are underway to try to improve understanding of and the ability to predict how stressors ultimately affect marine mammal populations (e.g., King et al., 2015; New et al., 2013a; New et

al., 2013b; Pirotta et al., 2015a). With respect to acoustically-induced stress, this includes not only determining how and to what degree various types of anthropogenic sound cause stress in marine mammals, but what factors can mitigate those responses. Factors potentially affecting an animal's response to a stressor include the mammal's life history stage, sex, age, reproductive status, overall physiological and behavioral plasticity, and whether they are naïve or experienced with the sound [e.g., prior experience with a stressor may result in a reduced response due to habituation (Finneran & Branstetter, 2013; St. Aubin & Dierauf, 2001)]. Because there are many unknowns regarding the occurrence of acoustically-induced stress responses in marine mammals, the Navy assumes in its effect analysis that any physiological response (e.g., hearing loss or injury) or significant behavioral response is also associated with a stress response. The long-term goal is to improve the understanding of how effects of marine sound on marine mammals transfer between behavior and life functions and between life functions and vital rates. This understanding will facilitate assessment of the population level effects of anthropogenic sound on marine mammals. This field and development of a state-space model is ongoing.

Based on each species' life history information, expected behavioral patterns in the Study Area, and the application of robust mitigation procedures proposed in Chapter 11 (Mitigation Measures), HSTT training and testing activities are anticipated to have a negligible impact on marine mammal populations within the Study Area.

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8 Anticipated Impacts on Subsistence Uses

Potential marine mammal impacts resulting from the Proposed Action in the Hawaii-Southern California Training and Testing Study Area will be limited to individuals located in the Study Area and where no subsistence requirements exist. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

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9 Anticipated Impacts on Habitat

Activity components with the potential to impact marine mammal habitat as a result of the Proposed Action include: (1) changes in water quality, (2) the introduction of sound into the water column, and (3) temporary changes to prey distribution and abundance. Each of these components was considered in the HSTT EIS/OEIS and was determined to have no impact on marine mammal habitat. A summary of the conclusions are included below.

One NMFS-managed marine mammal species, the Hawaiian monk seal, has designated critical habitat in the Study Area (Figure 4-1). After an assessment of the potential impacts of training and testing activities on marine mammal critical habitat in the Study Area, the Navy has determined that acoustic sources, energy sources, physical disturbances and strikes, entanglement, ingestion, and indirect stressors will have no effect on the essential features of the Hawaiian monk seal critical habitat, i.e., (1) adjacent terrestrial and aquatic areas with characteristics preferred by monk seals for pupping and nursing; (2) shallow, sheltered aquatic areas adjacent to coastal locations preferred by monk seals for pupping and nursing; (3) marine areas from 0 to 500 m in depth preferred by juvenile and adult monk seals for foraging; (4) areas with low levels of anthropogenic disturbance; (5) marine areas with adequate prey quantity and quality; and (6) significant areas used by monk seals for hauling out, resting, or molting (National Oceanic and Atmospheric Administration, 2015a).

Water Quality. The HSTT EIS/OEIS analyzed the potential effects on water quality from military expended materials. Training and testing activities may introduce water quality constituents into the water column. Based on the analysis of the HSTT EIS/OEIS, military expended materials (e.g., undetonated explosive materials) would be released in quantities and at rates that would not result in a violation of any water quality standard or criteria. High-order explosions consume most of the explosive material, creating typical combustion products. For example, in the case of Royal Demolition Explosive, 98 percent of the products are common seawater constituents and the remainder is rapidly diluted below threshold effect level. Explosion by-products associated with high order detonations present no secondary stressors to marine mammals through sediment or water. However, low order detonations and unexploded ordnance present elevated likelihood of impacts on marine mammals.

Indirect effects of explosives and unexploded ordnance to marine mammals via sediment is possible in the immediate vicinity of the ordnance. Degradation products of Royal Demolition Explosive are not toxic to marine organisms at realistic exposure levels (Rosen & Lotufo, 2010). Relatively low solubility of most explosives and their degradation products means that concentrations of these contaminants in the marine environment are relatively low and readily diluted. Furthermore, while explosives and their degradation products were detectable in marine sediment approximately 6–12 in. away from degrading ordnance, the concentrations of these compounds were not statistically distinguishable from background beyond 3–6 ft. from the degrading ordnance. Taken together, it is possible that marine mammals could be exposed to degrading explosives, but it would be within a very small radius of the explosive (1–6 ft.).

Equipment used by the Navy within the Study Area, including ships and other marine vessels, aircraft, and other equipment, are also potential sources of by-products. All equipment is properly maintained in accordance with applicable Navy or legal requirements. All such operating equipment meets federal water quality standards, where applicable.

Sound in the Water Column. Various activities and events, both natural and anthropogenic, above and below the water's surface contribute to oceanic ambient or background noise. Anthropogenic noise in the area from non-Navy sources includes commercial shipping and recreational boats, and in-water explosives from commercial fishing use of explosive seal deterrents (Baumann-Pickering et al., 2013; Rice et al., 2017). Low frequency (15-30 Hz) ambient noise peaks during fall and winter are related to seasonal increased in fin whale calls (Rice et al., 2017).

Anthropogenic noise attributable to Navy training and testing activities in the Study Area emanates from multiple sources including low-frequency and hull-mounted mid-frequency active sonar, high-frequency and non hull-mounted mid-frequency active sonar, and explosives and other impulsive sounds. Such sound sources include mine countermeasure and neutralization activities; ordnance testing; gunnery, missile, and bombing exercises; torpedo testing, sinking exercises; vessels; and aircraft. Sound produced from training and testing activities in the Study Area is temporary and transitory. Passive acoustic monitoring documented periodic mid-frequency active sonar from Navy surface ships in the Southern California portion of the HSTT Study area with increased use during major training exercises and temporal gaps with no or limited unit level training between both major exercises (Rice et al., 2017).

The sounds produced can be widely dispersed or concentrated in small areas for varying periods. However, any anthropogenic noise attributed to Navy training and testing activities in the Study Area would be temporary and the affected area would be expected to immediately return to the original state when these activities cease.

Prey Distribution and Abundance. In terms of fish and invertebrate (e.g., squid) prey species in Southern California, the key pelagic species by biomass include Pacific sardines, northern anchovies, jack mackerel, Pacific mackerel, and market squid (Allen, 2006; Stierhoff et al., 2017; Wells et al., 2014). Sanddab, rockfish, market squid, Myctophiids, and pacific hake comprise the dominant mid-water fish assemblages (Sakuma et al., 2016). Other top nearshore pelagic fish include chub mackerel, jack mackerel, topsmelt, and jacksmelt (Allen, 2006). Pacific herring is more common from central California northward in the Pacific.

Fishes, like other vertebrates, have variety of different sensory systems to glean information from ocean around them (Astrup & Mohl, 1993; Astrup, 1999; Braun & Grande, 2008; Carroll et al., 2017; Hawkins & Johnstone, 1978; Ladich & Popper, 2004; Ladich & Schulz-Mirbach, 2016; Mann, 2016; Nedwell et al., 2004; Popper et al., 2003; Popper et al., 2005). Fish detect both pressure and particle motion (terrestrial vertebrates generally only detect pressure). Most marine fishes primarily detect particle motion using the inner ear and lateral line system, while some fishes possess additional morphological adaptations or specializations that can enhance their sensitivity to sound pressure, such as a gas-filled swim bladder (Braun & Grande, 2008; Popper & Fay, 2011).

Hearing capabilities vary considerably between different fish species with data only available for just over 100 species out of the 34,000 marine and freshwater fish species (Eschmeyer & Fong, 2016). In order to better understand acoustic impacts on fishes, fish hearing groups are defined by species that possess a similar continuum of anatomical features which result in varying degrees of hearing sensitivity (Popper and Hastings, 2009a). There are four hearing groups defined for all fish species (modified from Popper et al., 2014) within this analysis and they include 1) fishes without a swim bladder (e.g., flatfish, sharks, rays, etc.), 2) fishes with a swim bladder not involved in hearing (e.g., salmon, cod, pollock, etc.), 3) fishes with a swim bladder involved in hearing (e.g., sardines, anchovy, herring, etc.), and 4) fishes with a swim bladder involved in hearing and high-frequency hearing (e.g., shad and menhaden). Most

marine mammal fish prey species would not be likely to perceive or hear Navy mid- or high-frequency sonars (see Figure 9 1). Within Southern California, the Clupeiformes order of fish include the Pacific sardine (Clupeidae), and northern anchovy (Engraulidae), key forage fish in Southern California. While hearing studies have not been done on sardines and northern anchovies, it would not be unexpected for them to have hearing similarities to Pacific herring (up to 2-5 kHz) (Mann et al., 2005). Currently, less data are available to estimate the range of best sensitivity for fishes without a swim bladder.

In terms of physiology, multiple scientific studies have documented a lack of mortality or physiological effects to fish from exposure to low- and mid-frequency sonar and other sounds (Halvorsen et al., 2012; Jørgensen et al., 2005; Juanes et al., 2017; Kane et al., 2010; Kvadsheim & Sevaldsen, 2005; Popper et al., 2007; Popper et al., 2016; Watwood et al., 2016). Techer et al. (2017) exposed carp in floating cages for up to 30 days to low-power 23 and 46 kHz source without any significant physiological response. Other studies have documented either a lack of TTS in species whose hearing range cannot perceive Navy sonar, or for those species that could perceive sonar-like signals, any TTS experienced would be recoverable (Halvorsen et al., 2012; Ladich & Fay, 2013; Popper & Hastings, 2009a, 2009b; Popper et al., 2014; Smith, 2016). Only fishes that have specializations that enable them to hear sounds above about 2,500 Hz (2.5 kHz) such as herring (Halvorsen et al., 2012; Mann et al., 2005; Mann, 2016; Popper et al., 2014) would have the potential to receive TTS or exhibit behavioral responses from exposure to mid-frequency sonar. In addition, any sonar induced TTS to fish whose hearing range could perceive sonar would only occur in the narrow spectrum of the source (e.g., 3.5 kHz) compared to the fish's total hearing range (e.g., 0.01 kHz to 5kHz). Overall, Navy sonar sources are much narrower in terms of source frequency compared to a given fish species full hearing range (see examples in Figure 9-1).

In terms of behavioral responses, Juanes et al. (2017) discuss the potential for negative impacts from anthropogenic soundscapes on fish, but the author's focus was on broader based sounds such as ship and boat noise sources. Watwood et al. (2016) also documented no behavioral responses by reef fish after exposure to mid-frequency active sonar. Doksaeter et al. (2009; 2012) reported no behavioral responses to mid-frequency naval sonar by Atlantic herring, specifically, no escape reactions (vertically or horizontally) observed in free swimming herring exposed to mid-frequency sonar transmissions. Based on these results (Doksaeter et al., 2009; Doksaeter et al., 2012; Sivle et al., 2012), Sivle et al. (2014) created a model in order to report on the possible population-level effects on Atlantic herring from active naval sonar. The authors concluded that the use of naval sonar poses little risk to populations of herring regardless of season, even when the herring populations are aggregated and directly exposed to sonar. Finally, Bruintjes et al. (2016) commented that fish exposed to any short-term noise within their hearing range might initially startle, but would quickly return to normal behavior.

Occasional behavioral reactions to intermittent explosions and impulsive sound sources are unlikely to cause long-term consequences for individual fish or populations. Fish that experience hearing loss as a result of exposure to explosions and impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. However, PTS has not been known to occur in fishes and any hearing loss in fish may be as temporary as the timeframe required to repair or replace the sensory cells that were damaged or destroyed (Popper et al., 2005; Popper et al., 2014; Smith et al., 2006). It is not known if damage to auditory nerve fibers could occur, and if so, whether fibers would recover during this process. It is also possible for fish to be injured or killed by an explosion in the immediate vicinity of the surface from dropped or fired ordnance, or near the bottom from shallow water bottom-placed underwater mine warfare detonations. Physical effects from pressure waves generated by underwater sounds (e.g., underwater explosions) could potentially affect fish within

proximity of training or testing activities. The shock wave from an underwater explosion is lethal to fish at close range, causing massive organ and tissue damage and internal bleeding (Keevin & Hempen, 1997). At greater distance from the detonation point, the extent of mortality or injury depends on a number of factors including fish size, body shape, orientation, and species (Keevin & Hempen, 1997; Wright, 1982). At the same distance from the source, larger fish are generally less susceptible to death or injury, elongated forms that are round in cross-section are less at risk than deep-bodied forms, and fish oriented sideways to the blast suffer the greatest impact (Edds-Walton & Finneran, 2006; O'Keeffe, 1984; O'Keeffe & Young, 1984; Wiley et al., 1981; Yelverton et al., 1975). Species with gas-filled organs have a higher potential for mortality than those without them (Gaspin, 1975; Gaspin et al., 1976; Goertner et al., 1994).

Fish not killed or driven from a location by an explosion might change their behavior, feeding pattern, or distribution. Changes in behavior of fish have been observed as a result of sound produced by explosives, with effect intensified in areas of hard substrate (Wright, 1982). However, Navy explosive use avoids hard substrate to the best extent practical during underwater detonations, or deep-water surface detonations (distance from bottom). Stunning from pressure waves could also temporarily immobilize fish, making them more susceptible to predation.

In conclusion, for fishes exposed to Navy sonar, there would be limited sonar use spread out in time and space across large offshore areas such that only small areas are actually ensonified (10’s of miles) compared to the total life history distribution of fish prey species. There would be no probability for mortality and physical injury from sonar, and for most species, no or little potential for hearing or behavioral effects, except to a few select fishes with hearing specializations (e.g., herring) that could perceive mid-frequency sonar. Training and testing exercises involving explosions are dispersed in space and time; therefore, repeated exposure of individual fishes are unlikely. Morality and injury effects to fishes from explosives would be localized around the area of a given in-water explosion, but only if individual fish and the explosive (and immediate pressure field) were co-located at the same time. Fishes deeper in the water column or on the bottom would not be affected by water surface explosions. Repeated exposure of individual fish to sound and energy from underwater explosions is not likely given fish movement patterns, especially schooling prey species. Most acoustic effects, if any, are expected to be short-term and localized. Long-term consequences for fish populations including key prey species within the HSTT Study Area would not be expected.

Data on response of invertebrates such as squid, another marine mammal prey species, to anthropogenic sound is more limited (de Soto, 2016; Sole et al., 2017b). Sole et al. (2017b) reported physiological injuries to cuttlefish in cages placed at-sea when exposed during a controlled exposure experiment to low-frequency sources (315 Hz, 139 to 142 dB re 1 μPa^2 and 400 Hz, 139 to 141 dB re 1 μPa^2). Fewtrell and McCauley (2012) reported squids maintained in cages displayed startle responses and behavioral changes when exposed to seismic air gun sonar (136-162 re 1 $\mu Pa^2 \cdot s$). However, the sources Sole et al. (2017a) and Fewtrell and McCauley (2012) used are not similar and much lower than typical Navy sources within the HSTT Study Area. Nor do the studies address the issue of individual displacement outside of a zone of impact when exposed to sound. Squids, like most fish species, are likely more sensitive to low frequency sounds, and may not perceive mid- and high-frequency sonars such as Navy sonars. Cumulatively for squid as a prey species, individual and population impacts from exposure to Navy sonar and explosives, like fish, are not likely to be significant, and explosive impacts would be shore-term and localized.

Vessels and in-water devices do not normally collide with adult fish, most of which can detect and avoid them. Exposure of fishes to vessel strike stressors is limited to those fish groups that are large, slow-moving, and may occur near the surface, such as ocean sunfish, whale sharks, basking sharks, and manta rays. These species are distributed widely in offshore portions of the Study Area. Any isolated cases of a Navy vessel striking an individual could injure that individual, impacting the fitness of an individual fish. Vessel strikes would not pose a risk to most of the other marine fish groups, because many fish can detect and avoid vessel movements, making strikes rare and allowing the fish to return to their normal behavior after the ship or device passes. As a vessel approaches a fish, they could have a detectable behavioral or physiological response (e.g., swimming away and increased heart rate) as the passing vessel displaces them. However, such reactions are not expected to have lasting effects on the survival, growth, recruitment, or reproduction of these marine fish groups at the population level.

In addition to fish, prey sources such as marine invertebrates could potentially be impacted by sound stressors as a result of the proposed activities. However, most marine invertebrates' ability to sense sounds is very limited. In most cases, marine invertebrates would not respond to impulsive and non-impulsive sounds, although they may detect and briefly respond to nearby low-frequency sounds. These short-term responses would likely be inconsequential to invertebrate populations. Explosions and pile driving could kill or injure nearby marine invertebrates. Vessels also have the potential to impact marine invertebrates by disturbing the water column or sediments, or directly striking organisms (Bishop, 2008). The propeller wash (water displaced by propellers used for propulsion) from vessel movement and water displaced from vessel hulls can potentially disturb marine invertebrates in the water column and is a likely cause of zooplankton mortality (Bickel et al., 2011). The localized and short-term exposure to explosions or vessels could displace, injure, or kill zooplankton, invertebrate eggs or larvae, and macro-invertebrates. However, mortality or long-term consequences for a few animals is unlikely to have measureable effects on overall stocks or populations. Long-term consequences to marine invertebrate populations would not be expected as a result of exposure to sounds or vessels in the Study Area.

Military expended materials resulting from training and testing activities could potentially result in minor long-term changes to benthic habitat. Military expended materials may be colonized over time by benthic organisms that prefer hard substrate and would provide structure that could attract some species of fish or invertebrates. Overall, the combined impacts of sound exposure, explosions, vessel strikes, and military expended materials resulting from the proposed activities would not be expected to have measureable effects on populations of marine mammal prey species.

Overall, the combined impacts of the Proposed Action would not be expected to have measureable effects on populations of marine mammal prey species.

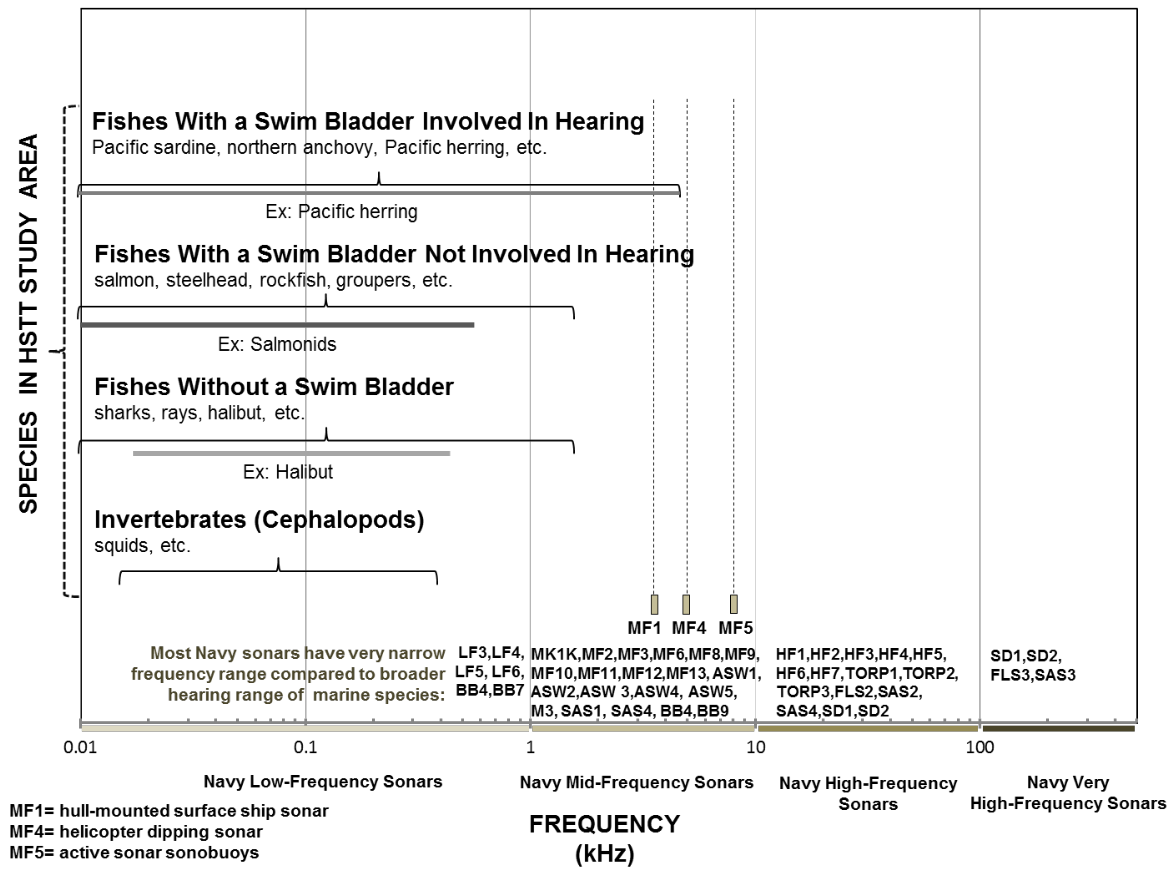

Figure 9-1: Fish Hearing Groups And U.S. Navy Sonars Frequency Ranges Used In HSTT

For fish hearing ranges, brackets indicate general frequency detection across the widest range known for each fish hearing group after review of scientific literature on freshwater and marine fish hearing. The science of fish hearing studies is evolving and not all studies are as robust as others. Therefore, as a conservative consideration accounting for the variation in hearing research study design, the lowest and highest values are used to define the fish hearing group brackets. Overall, any fish that falls within a given hearing group may or may not be able to detect the full range of frequencies in a given hearing group range. Because of this, narrow bars underneath a bracket represent example species within the study area that fit into a hearing group. These narrow bars show the minimum and maximum measured hearing thresholds from specific species regardless of testing methodology or study limitations. For US Navy sonars, although each sonar bin is represented graphically (e.g., low-frequency sonars less than 1 kHz, mid-frequency sonars between 1-10 kHz, etc.), not all sources within each bin would operate at all the displayed frequencies. Example mid-frequency sources are provided to further demonstrate this. SD1 and SD2 bins can use either mid- or very-high frequency depending on the given system. BB4 and SAS4 are more broad band source bins.(Fish hearing citations supporting Figure 9-1 include Hawkins and Johnstone 1978; Fay 1988, Astrup and Mohl 1993; Popper and Carison 1998; Astrup 1999; Popper et al. 2003; Ladich and Popper 2004; Nedwell et al. 2004; Jorgensen et al. 2005; Lovell et al. 2005; Mann et al. 2005; Popper 2008; Popper 2009; Popper and Hastings 2009a, 2009b; Popper and Fay 2011; Ladich and Fay 2013; Popper et al. 2014, Sivle et al. 2015)

10 Anticipated Effects of Habitat Impacts on Marine Mammals

The proposed training and testing events for the HSTT Study Area are not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations. Based on the discussions in Chapter 9 (Anticipated Impacts on Habitat), there will be no impacts on marine mammals resulting from loss or modification of marine mammal habitat.

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11 Mitigation Measures

The Navy will implement mitigation measures to avoid or reduce potential impacts from acoustic, explosive, and physical disturbance and strike stressors. The Navy's mitigation measures are organized into two categories: procedural mitigation and mitigation areas. A complete discussion of the evaluation process used to develop, assess, and select mitigation measures can be found in Chapter 5 (Mitigation) of the HSTT EIS/OEIS.

The mitigation measures are designed to achieve one or more benefit, such as the following:

- Effect the least practicable adverse impact on marine mammal species or stocks and their habitat, and have a negligible impact on marine mammal species and stocks (as required under the Marine Mammal Protection Act [MMPA]);

- Ensure that the Proposed Action does not jeopardize the continued existence of endangered or threatened species, or result in destruction or adverse modification of critical habitat (as required under the Endangered Species Act [ESA]);

- Avoid or minimize adverse effects on essential fish habitat (as required under the Magnuson-Stevens Fishery Conservation and Management Act);

The following sections summarize the mitigation measures that will be implemented in association with the training and testing activities analyzed in this document. Navy operators, environmental planners, and scientific experts developed mitigation that is likely to be effective at avoiding or reducing impacts on biological or cultural resources, and that is practicable to implement by the definitions provided in Section 5.2.3 (Practicability of Implementation). The Navy's mitigation is organized into two categories: procedural mitigation and mitigation areas.

11.1 Procedural Mitigation

Procedural mitigation is mitigation that the Navy will implement whenever and wherever an applicable training or testing activity takes place within the Study Area. The Navy customizes procedural mitigation for each applicable activity category or stressor. Procedural mitigation generally involves: (1) the use of one or more trained Lookouts to diligently observe for specific biological resources within a mitigation zone, (2) requirements for Lookouts to immediately communicate sightings of specific biological resources to the appropriate watch station for information dissemination, and (3) requirements for the watch station to implement mitigation (e.g., halt an activity) until certain recommencement conditions have been met.

The first procedural mitigation (Table 11-1) is designed to aid Lookouts and other applicable personnel with their observation, environmental compliance, and reporting responsibilities. The remainder of the procedural mitigations are organized by stressor type and activity category.

Table 11-1: Procedural Mitigation for Environmental Awareness and Education

Procedural Mitigation Description
Stressor or Activity • All training and testing activities, as applicable
Mitigation Zone Size and Mitigation Requirements • Appropriate personnel involved in mitigation and training or testing activity reporting under the Proposed Action will complete one or more modules of the U.S Navy Afloat Environmental Compliance Training Series, as identified in their career path training plan. Modules include: o **Introduction to the U.S. Navy Afloat Environmental Compliance Training Series.** The introductory module provides information on environmental laws (e.g., ESA, MMPA) and the corresponding responsibilities relevant to Navy training and testing. The material explains why environmental compliance is important in supporting the Navy's commitment to environmental stewardship. o **Marine Species Awareness Training.** All bridge watch personnel, Commanding Officers, Executive Officers, maritime patrol aircraft aircrews, anti-submarine warfare and mine warfare rotary-wing aircrews, Lookouts, and equivalent civilian personnel must successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The Marine Species Awareness Training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures. Navy biologists developed Marine Species Awareness Training to improve the effectiveness of visual observations for biological resources, focusing on marine mammals and sea turtles, and including floating vegetation, jellyfish aggregations, and flocks of seabirds. o **U.S. Navy Sonar Positional Reporting System and Marine Mammal Incident Reporting.** This module provides instruction on the procedures and activity reporting requirements for the Sonar Positional Reporting System and marine mammal incident reporting. o **U.S. Navy Protective Measures Assessment Protocol.** This module provides the necessary instruction for accessing mitigation requirements during the event planning phase using the Protective Measures Assessment Protocol software tool. Also related are annual marine mammal awareness messages promulgated annual to Fleet units: <u>For HSTT Hawaii:</u> • **Humpback Whale Awareness Notification Message Area (November 15 – April 15):** − The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including humpback whales. − To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including humpback whales), that when concentrated seasonally, may become vulnerable to vessel strikes. − Lookouts will use the information from the awareness notification message to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.

For HSTT Southern California:

- **Blue Whale Awareness Notification Message Area (June 1 – October 31)**:
  - The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including blue whales.
  - To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including blue whales), that when concentrated seasonally, may become vulnerable to vessel strikes.
  - Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.
- **Gray Whale Awareness Notification Message Area (November 1 – March 31):**
  - The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including gray whales.
  - To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including gray whales), that when concentrated seasonally, may become vulnerable to vessel strikes.
  - Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in the implementation of procedural mitigation.
- **Fin Whale Awareness Notification Message Area (November 1 – May 31):**
  - The Navy will issue a seasonal awareness notification message to alert ships and aircraft operating in the area to the possible presence of concentrations of large whales, including fin whales.
  - To maintain safety of navigation and to avoid interactions with large whales during transits, the Navy will instruct vessels to remain vigilant to the presence of large whale species (including fin whales), that when concentrated seasonally, may become vulnerable to vessel strikes.
  - Lookouts will use the information from the awareness notification messages to assist their visual observation of applicable mitigation zones during training and testing activities and to aid in implementation of procedural mitigation.

11.1.1 Acoustic Stressors

Mitigation measures for acoustic stressors are provided in Table 11-2 through Table 11-5.

Table 11-2: Procedural Mitigation for Active Sonar

Procedural Mitigation Description
Stressor or Activity • Low-frequency active sonar, mid-frequency active sonar, high-frequency active sonar • For vessel-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned surface vessels (e.g., sonar sources towed from manned surface platforms). • For aircraft-based active sonar activities, mitigation applies only to sources that are positively controlled and deployed from manned aircraft that do not operate at high altitudes (e.g., rotary-wing aircraft). Mitigation does not apply to active sonar sources deployed from unmanned aircraft or aircraft operating at high altitudes (e.g., maritime patrol aircraft).
Number of Lookouts and Observation Platform • Hull-mounted sources: o Platforms without space or manning restrictions while underway: 2 Lookouts at the forward part of the ship o Platforms with space or manning restrictions while underway: 1 Lookout at the forward part of a small boat or ship o Platforms using active sonar while moored or at anchor (including pierside): 1 Lookout • Sources that are not hull-mounted: o 1 Lookout on the ship or aircraft conducting the activity
Mitigation Zone Size and Mitigation Requirements • Prior to the start of the activity (e.g., when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence use of active sonar. • Low-frequency active sonar at 200 decibels (dB) or more, and hull-mounted mid-frequency active sonar will implement the following mitigation zones: o During the activity, observe for marine mammals; power down active sonar transmission by 6 dB if resource is observed within 1,000 yd. of the sonar source; power down by an additional 4 dB (10 dB total) if resource is observed within 500 yd. of the sonar source; and cease transmission if resource is observed within 200 yd. of the sonar source. • Low-frequency active sonar below 200 dB, mid-frequency active sonar sources that are not hull-mounted, and high-frequency active sonar will implement the following mitigation zone: o During the activity, observe for marine mammals; cease active sonar transmission if resource is observed within 200 yd. of the sonar source. • To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence active sonar transmission until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the sonar source; (3) the mitigation zone has been clear from any additional sightings for 10 min. for aircraft-deployed sonar sources or 30 min. for vessel-deployed sonar sources; (4) for mobile activities, the active sonar source has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting; or (5) for activities using hull-mounted sonar, the Lookout concludes that dolphins are deliberately closing in on the ship to ride the ship's bow wave, and are therefore out of the main transmission axis of the sonar (and there are no other marine mammal sightings within the mitigation zone).

Table 11-3: Procedural Mitigation for Air Guns

Procedural Mitigation Description
Stressor or Activity • Air guns
Number of Lookouts and Observation Platform • 1 Lookout positioned on a ship or pierside

Mitigation Zone Size and Mitigation Requirements
• 150 yd. around the air gun:
    o Prior to the start of the activity (e.g., when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence use of air guns.
    o During the activity, observe for marine mammals; if resource is observed, cease use of air guns.
    o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence the use of air guns until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the air gun; (3) the mitigation zone has been clear from any additional sightings for 30 min.; or (4) for mobile activities, the air gun has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Table 11-4: Procedural Mitigation for Pile Driving

Procedural Mitigation Description
Stressor or Activity • Pile driving and pile extraction sound during Elevated Causeway System Training
Number of Lookouts and Observation Platform • 1 Lookout positioned on the shore, the elevated causeway, or a small boat

Mitigation Zone Size and Mitigation Requirements
• 100 yd. around the pile driver:
    o 30 minutes prior to the start of the activity, observe for floating vegetation and marine mammals; if resource is observed, do not commence impact pile driving or vibratory pile extraction.
    o During the activity, observe for marine mammals; if resource is observed, cease impact pile driving or vibratory pile extraction.
    o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence pile driving until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the pile driving location; or (3) the mitigation zone has been clear from any additional sightings for 30 min.

Table 11-5: Procedural Mitigation for Weapons Firing Noise

Procedural Mitigation Description
Stressor or Activity • Weapons firing noise associated with large-caliber gunnery activities
Number of Lookouts and Observation Platform • 1 Lookout positioned on the ship conducting the firing • Depending on the activity, the Lookout could be the same as the one described in Table 11-8 (Procedural Mitigation for Explosive Medium-Caliber and Large-Caliber Projectiles) or Table 11-18 (Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions)
Mitigation Zone Size and Mitigation Requirements • 30° on either side of the firing line out to 70 yd. from the muzzle of the weapon being fired: o Prior to the start of the activity, observe for floating vegetation and marine mammals; if resource is observed, do not commence weapons firing. o During the activity, observe for marine mammals; if resource is observed, cease weapons firing. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence weapons firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the firing ship; (3) the mitigation zone has been clear from any additional sightings for 30 min.; or (4) for mobile activities, the firing ship has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

11.1.2 Explosive Stressors

Mitigation measures for explosive stressors are provided in Table 11-6 through Table 11-15.

Table 11-6: Procedural Mitigation for Explosive Sonobuoys

Procedural Mitigation Description
Stressor or Activity • Explosive sonobuoys
Number of Lookouts and Observation Platform • 1 Lookout positioned in an aircraft or on small boat
Mitigation Zone Size and Mitigation Requirements • 600 yd. around an explosive sonobuoy: o Prior to the start of the activity (e.g., during deployment of a sonobuoy field, which typically lasts 20–30 min.), conduct passive acoustic monitoring for marine mammals, and observe for floating vegetation and marine mammals; if resource is visually observed, do not commence sonobuoy or source/receiver pair detonations. o During the activity, observe for marine mammals; if resource is observed, cease sonobuoy or source/receiver pair detonations. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence the use of explosive sonobuoys until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the sonobuoy; or (3) the mitigation zone has been clear from any additional sightings for 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained.

Table 11-7: Procedural Mitigation for Explosive Torpedoes

Procedural Mitigation Description
Stressor or Activity • Explosive torpedoes
Number of Lookouts and Observation Platform • 1 Lookout positioned in an aircraft
Mitigation Zone Size and Mitigation Requirements • 2,100 yd. around the intended impact location: o Prior to the start of the activity (e.g., during deployment of the target), conduct passive acoustic monitoring for marine mammals, and observe for floating vegetation, jellyfish aggregations and marine mammals; if resource is visually observed, do not commence firing. o During the activity, observe for marine mammals and jellyfish aggregations; if resource is observed, cease firing. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained. o After completion of the activity, observe for marine mammals; if any injured or dead resources are observed, follow established incident reporting procedures.

Table 11-8: Procedural Mitigation for Explosive Medium-Caliber and Large-Caliber Projectiles

Procedural Mitigation Description
Stressor or Activity • Gunnery activities using explosive medium-caliber and large-caliber projectiles • Mitigation applies to activities using a surface target
Number of Lookouts and Observation Platform • 1 Lookout on the vessel or aircraft conducting the activity
Mitigation Zone Size and Mitigation Requirements • 200 yd. around the intended impact location for air-to-surface activities using explosive medium-caliber projectiles, or • 600 yd. around the intended impact location for surface-to-surface activities using explosive medium-caliber projectiles, or • 1,000 yd. around the intended impact location for surface-to-surface activities using explosive large-caliber projectiles: o Prior to the start of the activity (e.g., when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing. o During the activity, observe for marine mammals; if resource is observed, cease firing. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 min. for aircraft-based firing or 30 min. for vessel-based firing; or (4) for activities using mobile targets, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Table 11-9: Procedural Mitigation for Explosive Missiles and Rockets

Procedural Mitigation Description
Stressor or Activity • Aircraft-deployed explosive missiles and rockets • Mitigation applies to activities using a surface target
Number of Lookouts and Observation Platform • 1 Lookout positioned in an aircraft
Mitigation Zone Size and Mitigation Requirements • 900 yd. around the intended impact location during activities for missiles or rockets with 0.6–20 lb. net explosive weight, or • 2,000 yd. around the intended impact location for missiles with 21–500 lb. net explosive weight: o Prior to the start of the activity (e.g., during a fly-over of the mitigation zone), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing. o During the activity, observe for marine mammals; if resource is observed, cease firing. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained.

Table 11-10: Procedural Mitigation for Explosive Bombs

Procedural Mitigation Description
Stressor or Activity • Explosive bombs
Number of Lookouts and Observation Platform • 1 Lookout positioned in the aircraft conducting the activity
Mitigation Zone Size and Mitigation Requirements • 2,500 yd. around the intended target: o Prior to the start of the activity (e.g., when arriving on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence bomb deployment. o During target approach, observe for marine mammals; if resource is observed, cease bomb deployment. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence bomb deployment until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended target; (3) the mitigation zone has been clear from any additional sightings for 10 min.; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Table 11-11: Procedural Mitigation for Sinking Exercises

Procedural Mitigation Description
Stressor or Activity • Sinking exercises
Number of Lookouts and Observation Platform • 2 Lookouts (one positioned in an aircraft and one on a vessel)
Mitigation Zone Size and Mitigation Requirements • 2.5 NM around the target ship hulk: o 90 min. prior to the first firing, conduct aerial observations for floating vegetation, jellyfish aggregations and marine mammals; if resource is observed, do not commence firing. o During the activity, conduct passive acoustic monitoring and visually observe for marine mammals from the vessel; if resource is visually observed, cease firing. o Immediately after any planned or unplanned breaks in weapons firing of longer than 2 hours, observe for marine mammals from the aircraft and vessel; if resource is observed, do not commence firing. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the target ship hulk; or (3) the mitigation zone has been clear from any additional sightings for 30 min. o For 2 hours after sinking the vessel (or until sunset, whichever comes first), observe for marine mammals; if any injured or dead resources are observed, follow established incident reporting procedures.

Table 11-12: Procedural Mitigation for Explosive Mine Countermeasure and Neutralization Activities

Procedural Mitigation Description
Stressor or Activity • Explosive mine countermeasure and neutralization activities
Number of Lookouts and Observation Platform • 1 Lookout positioned on a vessel or in an aircraft when implementing the smaller mitigation zone • 2 Lookouts (one positioned in an aircraft and one on a small boat) when implementing the larger mitigation zone
Mitigation Zone Size and Mitigation Requirements • 600 yd. around the detonation site for activities using 0.1–5-lb. net explosive weight, or • 2,100 yd. around the detonation site for 6–650 lb. net explosive weight (including high explosive target mines): o Prior to the start of the activity (e.g., when maneuvering on station; typically, 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained), observe for floating vegetation and marine mammals; if resource is observed, do not commence detonations. o During the activity, observe for marine mammals; if resource is observed, cease detonations. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence detonations until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to detonation site; or (3) the mitigation zone has been clear from any additional sightings for 10 min. when the activity involves aircraft with fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained. o After completion of the activity, observe for marine mammals (typically 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained); if any injured or dead resources are observed, follow established incident reporting procedures.

Table 11-13: Procedural Mitigation for Explosive Mine Neutralization Activities Involving Navy Divers

Procedural Mitigation Description
Stressor or Activity • Explosive mine neutralization activities involving Navy divers
Number of Lookouts and Observation Platform • 2 Lookouts (two small boats with one Lookout each, or one Lookout on a small boat and one in a rotary-wing aircraft) when implementing the smaller mitigation zone • 4 Lookouts (two small boats with two Lookouts each), and a pilot or member of an aircrew will serve as an additional Lookout if aircraft are used during the activity, when implementing the larger mitigation zone
Mitigation Zone Size and Mitigation Requirements • The Navy will not set time-delay firing devices (0.1–29 lb. net explosive weight) to exceed 10 min. • 500 yd. around the detonation site during activities under positive control using 0.1–20 lb. net explosive weight, or • 1,000 yd. around the detonation site during all activities using time-delay fuses (0.1–29 lb. net explosive weight) and during activities under positive control using 21–60 lb. net explosive weight: o Prior to the start of the activity (e.g., when maneuvering on station for activities under positive control; 30 min. for activities using time-delay firing devices), observe for floating vegetation and marine mammals; if resource is observed, do not commence detonations or fuse initiation. o During the activity, observe for marine mammals; if resource is observed, cease detonations or fuse initiation. o All divers placing the charges on mines will support the Lookouts while performing their regular duties and will report all sightings to their supporting small boat or Range Safety Officer. o To the maximum extent practicable depending on mission requirements, safety, and environmental conditions, boats will position themselves near the mid-point of the mitigation zone radius (but outside of the detonation plume and human safety zone), will position themselves on opposite sides of the detonation location (when two boats are used), and will travel in a circular pattern around the detonation location with one Lookout observing inward toward the detonation site and the other observing outward toward the perimeter of the mitigation zone. o If used, aircraft will travel in a circular pattern around the detonation location to the maximum extent practicable. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence detonations or fuse initiation until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the detonation site; (3) the mitigation zone has been clear from any additional sightings for 10 min. during activities under positive control with aircraft that have fuel constraints, or 30 min. during activities under positive control with aircraft that are not typically fuel constrained and during activities using time-delay firing devices. o After completion of an activity using time-delay firing devices, observe for marine mammals for 30 min.; if any injured or dead resources are observed, follow established incident reporting procedures.

Table 11-14: Procedural Mitigation for Underwater Demolition Multiple Charge – Mat Weave and Obstacle Loading

Procedural Mitigation Description
Stressor or Activity • Underwater Demolition Multiple Charge – Mat Weave and Obstacle Loading exercises
Number of Lookouts and Observation Platform • 2 Lookouts (one on a small boat and one on shore from an elevated platform)
Mitigation Zone Size and Mitigation Requirements • 700 yd. around the detonation site: o For 30 min. prior to the first detonation, the Lookout positioned on a small boat will observe for floating vegetation and marine mammals; if resource is observed, do not commence the initial detonation. o For 10 min. prior to the first detonation, the Lookout positioned on shore will use binoculars to observe for marine mammals; if resource is observed, do not commence the initial detonation until the mitigation zone has been clear of any additional sightings for a minimum of 10 min. o During the activity, observe for marine mammals; if resource is observed, cease detonations. o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence detonations until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the detonation site; or (3) the mitigation zone has been clear from any additional sightings for 10 min. (as determined by the shore observer). o After completion of the activity, the Lookout positioned on a small boat will observe for marine mammals for 30 min.; if any injured or dead resources are observed, follow established incident reporting procedures.

Table 11-15: Procedural Mitigation for Maritime Security Operations – Anti-Swimmer Grenades

Procedural Mitigation Description
Stressor or Activity • Maritime Security Operations – Anti-Swimmer Grenades
Number of Lookouts and Observation Platform • 1 Lookout positioned on the small boat conducting the activity
Mitigation Zone Size and Mitigation Requirements • 200 yd. around the intended detonation location: o Prior to the start of the activity (e.g., when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence detonations. o During the activity, observe for marine mammals; if resource is observed, cease detonations. • To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence detonations until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended detonation location; (3) the mitigation zone has been clear from any additional sightings for 30 min.; or (4) the intended detonation location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

11.1.3 Physical Disturbance and Strike Stressors

Mitigation measures for physical disturbance and strike stressors are provided in Table 11-16 through Table 11-20.

Table 11-16: Procedural Mitigation for Vessel Movement

Procedural Mitigation Description
<u>Stressor or Activity</u> • Vessel movement • The mitigation will not be applied if (1) the vessel's safety is threatened, (2) the vessel is restricted in its ability to maneuver (e.g., during launching and recovery of aircraft or landing craft, during towing activities, when mooring, etc.), (3) the vessel is operated autonomously, or (4) when impracticable based on mission requirements (e.g., during Amphibious Assault – Battalion Landing exercises).
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout on the vessel that is underway
<u>Mitigation Zone Size and Mitigation Requirements</u> • 500 yd. around whales: o When underway, observe for marine mammals; if a whale is observed, maneuver to maintain distance. • 200 yd. around all other marine mammals (except bow-riding dolphins and pinnipeds hauled out on man-made navigational structures, port structures, and vessels): o When underway, observe for marine mammals; if a marine mammal other than a whale, bow-riding dolphin, or hauled-out pinniped is observed, maneuver to maintain distance.

Table 11-17: Procedural Mitigation for Towed In-Water Devices

Procedural Mitigation Description
<u>Stressor or Activity</u> • Towed in-water devices • Mitigation applies to devices that are towed from a manned surface platform or manned aircraft • The mitigation will not be applied if the safety of the towing platform or in-water device is threatened
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout positioned on the manned towing platform
<u>Mitigation Zone Size and Mitigation Requirements</u> • 250 yd. around marine mammals: o During the activity, observe for marine mammals; if resource is observed, maneuver to maintain distance.

Table 11-18: Procedural Mitigation for Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions

Procedural Mitigation Description
Stressor or Activity • Gunnery activities using small-, medium-, and large-caliber non-explosive practice munitions • Mitigation applies to activities using a surface target
Number of Lookouts and Observation Platform • 1 Lookout positioned on the platform conducting the activity • Depending on the activity, the Lookout could be the same as the one described in Table 11-5 (Procedural Mitigation for Weapons Firing Noise)

Mitigation Zone Size and Mitigation Requirements
• 200 yd. around the intended impact location:
  o Prior to the start of the activity (e.g., when maneuvering on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing.
  o During the activity, observe for marine mammals; if resource is observed, cease firing.
  o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; (3) the mitigation zone has been clear from any additional sightings for 10 min. for aircraft-based firing or 30 min. for vessel-based firing; or (4) for activities using a mobile target, the intended impact location has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

Table 11-19: Procedural Mitigation for Non-Explosive Missiles and Rockets

Procedural Mitigation Description
Stressor or Activity • Aircraft-deployed non-explosive missiles and rockets • Mitigation applies to activities using a surface target
Number of Lookouts and Observation Platform • 1 Lookout positioned in an aircraft

Mitigation Zone Size and Mitigation Requirements
• 900 yd. around the intended impact location:
  o Prior to the start of the activity (e.g., during a fly-over of the mitigation zone), observe for floating vegetation and marine mammals; if resource is observed, do not commence firing.
  o During the activity, observe for marine mammals; if resource is observed, cease firing.
  o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence firing until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended impact location; or (3) the mitigation zone has been clear from any additional sightings for 10 min. when the activity involves aircraft that have fuel constraints, or 30 min. when the activity involves aircraft that are not typically fuel constrained.

Table 11-20: Procedural Mitigation for Non-Explosive Bombs and Mine Shapes

Procedural Mitigation Description
<u>Stressor or Activity</u> • Non-explosive bombs • Non-explosive mine shapes during mine laying activities
<u>Number of Lookouts and Observation Platform</u> • 1 Lookout positioned in an aircraft

<u>Mitigation Zone Size and Mitigation Requirements</u>
• 1,000 yd. around the intended target:
  o Prior to the start of the activity (e.g., when arriving on station), observe for floating vegetation and marine mammals; if resource is observed, do not commence bomb deployment or mine laying.
  o During approach of the target or intended minefield location, observe for marine mammals; if resource is observed, cease bomb deployment or mine laying.
  o To allow a sighted marine mammal to leave the mitigation zone, the Navy will not recommence bomb deployment or mine laying until one of the recommencement conditions has been met: (1) the animal is observed exiting the mitigation zone; (2) the animal is thought to have exited the mitigation zone based on a determination of its course, speed, and movement relative to the intended target or minefield location; (3) the mitigation zone has been clear from any additional sightings for 10 min.; or (4) for activities using mobile targets, the intended target has transited a distance equal to double that of the mitigation zone size beyond the location of the last sighting.

11.2 MITIGATION AREAS

In addition to procedural mitigation, the Navy will implement mitigation measures within mitigation areas to avoid or reduce potential impacts on marine mammals (Figure 11-3 through Figure 11-10), as well as seafloor resources (Figure 11-1 and Figure 11-2) that serve valuable ecosystem functions and could provide habitat for marine mammal prey species. A full technical analysis of the mitigation areas that the Navy considered for marine mammals is provided in Appendix K (Geographic Mitigation Assessment for Areas under Consideration within the Hawaii-Southern California Training and Testing Study Area) of the HSTT EIS/OEIS. The Navy considered a mitigation area to be effective if it met the following criteria:

- **The mitigation area is a key area of biological or ecological importance or contains cultural resources:** The best available science suggests that the mitigation area contains submerged cultural resources (e.g., shipwrecks) or is important to one or more species or resources for a biologically important life process (i.e., foraging, migration, reproduction) or ecological function (e.g., shallow-water coral reefs that provide critical ecosystem functions); and
- **The mitigation would result in an avoidance or reduction of impacts:** Implementing the mitigation would likely result in an avoidance or reduction of impacts on: (1) species, stocks, or populations of marine mammals based on data regarding seasonality, density, and animal behavior; or (2) other biological or cultural resources based on their distribution and physical properties. Furthermore, implementing the mitigation would not wittingly shift or transfer adverse effects from one species to another, or to a more vulnerable or sensitive species.

On an area-by-area and activity-by-activity basis, the Navy considered mitigation to be practicable to implement if it met all criteria listed below:

- **Implementing the mitigation is safe:** The mitigation would not increase safety risks to Navy personnel and equipment, or to the public. This includes factoring in the availability of aircraft emergency landing fields and the ability to de-conflict platforms and activities to ensure that training and testing activities do not impact each other, to avoid interaction with established commercial air traffic routes, and to avoid commercial vessel shipping lanes.
- **Implementing the mitigation is sustainable:** Activities are scheduled in proximity to homeports, home bases, associated training ranges, testing facilities, air squadrons, and existing infrastructure (e.g., instrumented underwater and land ranges) to maximize capabilities and minimize fuel use, transport time, and the time personnel must spend away from home. The mitigation would not result in excessive time away from homeport for Navy personnel or an impracticable increase in resource requirements, such as wear and tear on equipment, additional fuel, additional personnel, additional funding, or undue shifting of time spent on operational obligations to other tasks (e.g., external requirements that would take time away from focusing on mission requirements); and the mitigation is within the Navy's legal authority to implement.
- **Implementing the mitigation allows the Navy to continue meeting its Title 10 requirements to successfully accomplish military readiness objectives:** The Navy requires access to a variety of realistic tactical oceanographic and environmental conditions (e.g., varied bathymetry and open sea space) to maximize training effectiveness and meet testing program requirements, and the availability of sea space and air space that is large enough for training or testing activities to be completed without physical or logistical obstructions. Activities are planned and scheduled in compliance with the Optimized Fleet Response Plan, which details instructions on manning distribution, range scheduling, operational requirements, maintenance and modernization plans, quality of work and life for personnel, achieving training capabilities, and meeting strategic readiness objectives. The mitigation would not modify training and testing activities in a way that prevents the activity from meeting their intended objectives; does not cause an erosion of capabilities or reduction in perishable skills; does not decrease training or testing realism or access to necessary environmental or oceanographic conditions; does not present national security concerns (such as a reduction in the Navy's ability to be ready, maintain deployment schedules, or respond to national emergencies; or a requirement to provide advance notification of specific times and locations

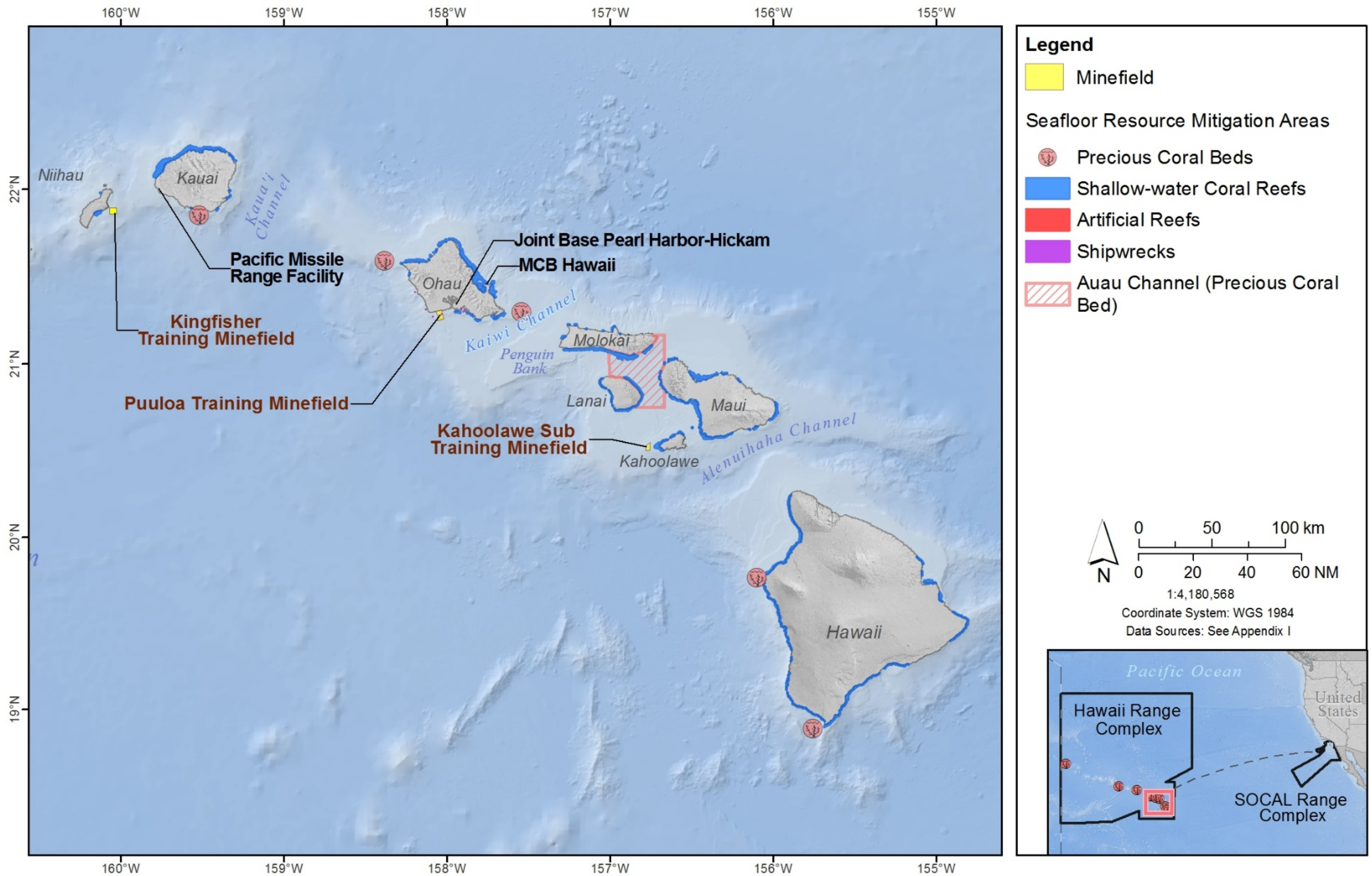
of Navy platforms, such as sonar, in a way that would compromise security); does not prevent ready access to facilities or range support structures; does not impede shipboard maintenance, repairs, or pierside testing prior to at-sea operations; and does not unduly delay testing associated with required acquisition milestones or as required on an as-needed basis to meet operational requirements

Information on the mitigation measures that the Navy will implement within mitigation areas is provided in Table 11-21 through Table 11 23. The mitigation applies year-round unless specified otherwise in the tables.

Table 11-21: Mitigation Areas for Seafloor Resources

Mitigation Area Description
<u>Resource Protection Focus</u> • Shallow-water coral reefs • Precious coral beds • Live hard bottom • Artificial reefs • Shipwrecks
<u>Stressor or Activity</u> • Explosives • Physical disturbance and strikes

<u>Mitigation Area Requirements</u>
• **Within the anchor swing circle of shallow-water coral reefs, precious coral beds, live hard bottom, artificial reefs, and shipwrecks**:
    o The Navy will not conduct precision anchoring (except in designated anchorages, such as areas adjoining the boat lanes off Silver Strand Training Complex and Naval Amphibious Base Coronado).
• **Within a 350 yd. radius of shallow-water coral reefs, precious coral beds, live hard bottom, artificial reefs, and shipwrecks:**
    o The Navy will not conduct explosive mine countermeasure and neutralization activities, or explosive mine neutralization activities involving Navy divers.
• Within a 350 yd. radius of shallow-water coral reefs and precious coral beds:
    o The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery activities using a surface target; explosive or non-explosive missile and rocket activities using a surface target; and explosive or non-explosive bombing and mine-laying activities.



Notes: MCB: Marine Corps Base; SOCAL: Southern California

Figure 11-1: Seafloor Resource Mitigation Areas off Hawaii

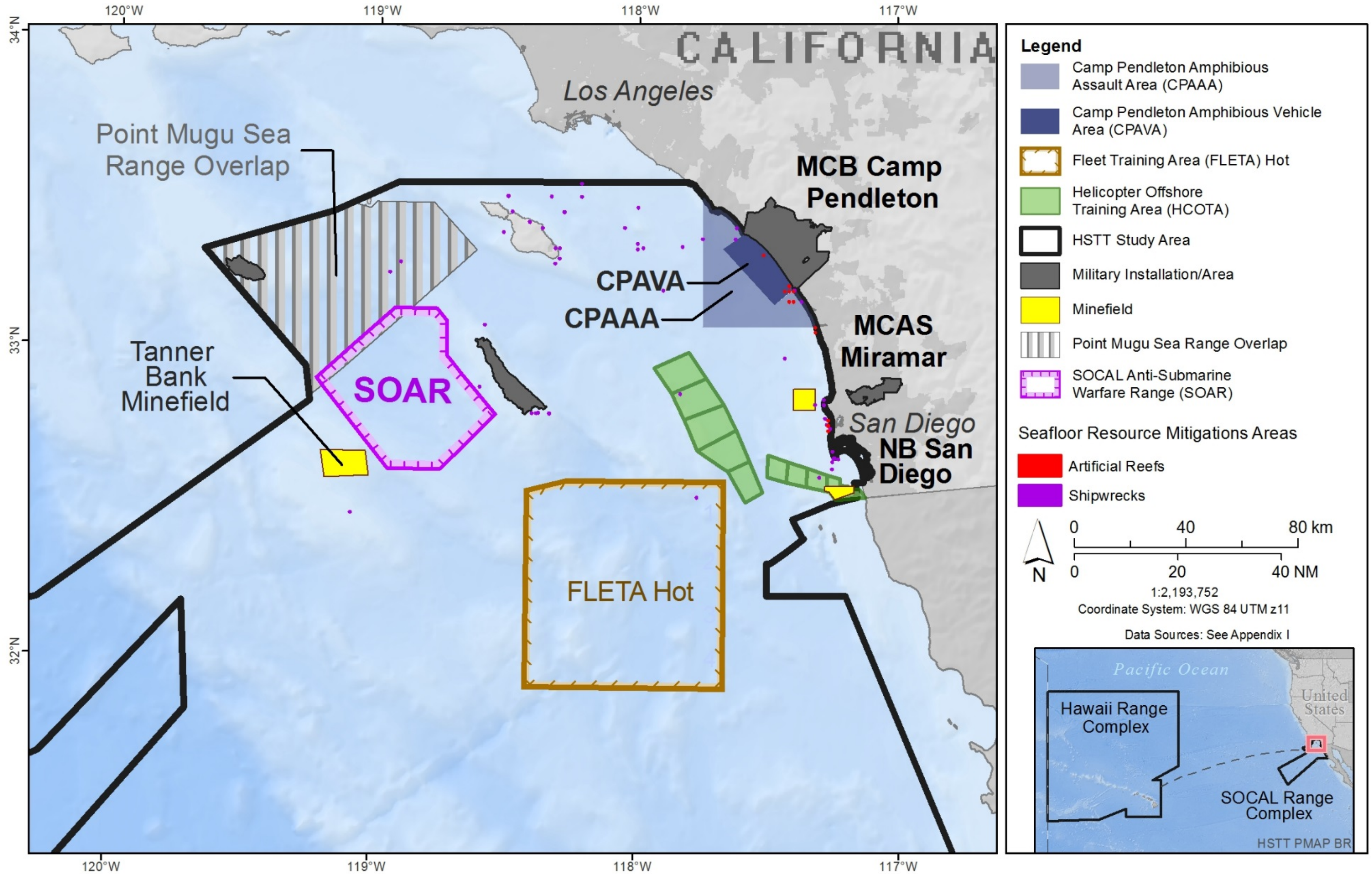


Figure 11-2: Seafloor Resource Mitigation Areas off Southern California

Table 11-22: Mitigation Areas for Marine Mammals in the Hawaii Range Complex

Mitigation Area Description
<u>**Stressor or Activity**</u> • Sonar • Explosives • Vessel strikes

<u>**Mitigation Area Requirements**</u>
• **West-side Hawaii Island Planning Awareness Area (year-round):**
  o The Navy will not conduct more than one Major Training Exercise – Large Integrated Anti-Submarine Warfare activity (e.g., Rim of the Pacific) every other year, and three Major Training Exercise – Medium Integrated Anti-Submarine Warfare activities (e.g., Fleet Exercise/Sustainment Exercise) per year using surface ship hull-mounted mid-frequency active sonar.
  o If the Navy needs to conduct additional major training exercises using surface ship hull-mounted mid-frequency active sonar in the mitigation area for national security, it will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports.
• **West-side Hawaii Island Cautionary Area (year-round):**
  o The Navy will not use in-water explosives during unit-level training, major training exercises, or testing events.
  o If a naval unit needs to use in-water explosives during unit-level training, major training exercises, or testing events in the mitigation area for national security, it will obtain permission from the appropriate delegated Command designee prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports.
• **East-side Hawaii Island Cautionary Area (year-round):**
  o The Navy will not use surface ship hull-mounted mid-frequency active sonar and in-water explosives during unit-level training, major training exercises, or testing events.
  o If a naval unit needs to use surface ship hull-mounted mid-frequency active sonar or in-water explosives during unit-level training, major training exercises, or testing events in the mitigation area for national security, it will obtain permission from the appropriate delegated Command designee prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports.
• **Humpback Whale Cautionary Area (November 15 – April 15):**
  o The Navy will not use surface ship hull-mounted mid-frequency active sonar during training or testing activities.
  o If a naval unit needs to use surface ship hull-mounted mid-frequency active sonar during training or testing activities in the mitigation area for national security, the Navy will obtain permission from the appropriate delegated Commander, Third Fleet or System Command delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports.
- Hours of surface ship hull-mounted mid-frequency active sonar reporting annual (Section 13.6)

Table 11-23: Mitigation Areas for Marine Mammals in the Southern California Portion of the Study Area

Mitigation Area Description
Stressor or Activity • Sonar • Explosives • Vessel strikes
Mitigation Area Requirements • **San Diego Arc Planning Awareness Area (June 1 – October 31):** o The Navy will not conduct more than a combined total of three Major Training Exercise – Large Integrated Anti-Submarine Warfare activity (e.g., Rim of the Pacific) or Major Training Exercise – Medium Integrated Anti-Submarine Warfare activities (e.g., Fleet Exercise/Sustainment Exercise) per applicable season using surface ship hull-mounted mid-frequency active sonar. o If the Navy needs to conduct additional major training exercises using surface ship hull-mounted mid-frequency active sonar in the mitigation area for national security, it will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports. • **San Diego Arc Cautionary Area (June 1 – October 31):** o The Navy will not use in-water explosives during large-caliber gunnery, torpedo, bombing, and missile (including 2.75” rockets) activities during unit-level training, major training exercises, or testing events. o If a naval unit needs to conduct large-caliber gunnery exercises, torpedo exercises, bombing exercises, and missile (including 2.75” rockets) activities using in-water explosives during unit-level training, major training exercises, or testing events in the mitigation area for national security, it will obtain permission from the appropriate delegated Command designee prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports. • **Channel Islands National Marine Sanctuary Cautionary Area (year-round):** o The Navy will not use surface ship hull-mounted mid-frequency active sonar and in-water explosives used in small-, medium-, and large-caliber gunnery; torpedo; bombing; and missile (including 2.75” rockets) activities during unit-level training, major training exercises, or testing events. o If a naval unit needs to use surface ship hull-mounted mid-frequency active sonar and in-water explosives in small-, medium-, and large-caliber gunnery; torpedo; bombing; and missile (including 2.75” rockets) activities during unit-level training, major training exercises, or testing events in the mitigation area for national security, it will obtain permission from the appropriate delegated Command designee prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in any associated annual training or testing activity reports.

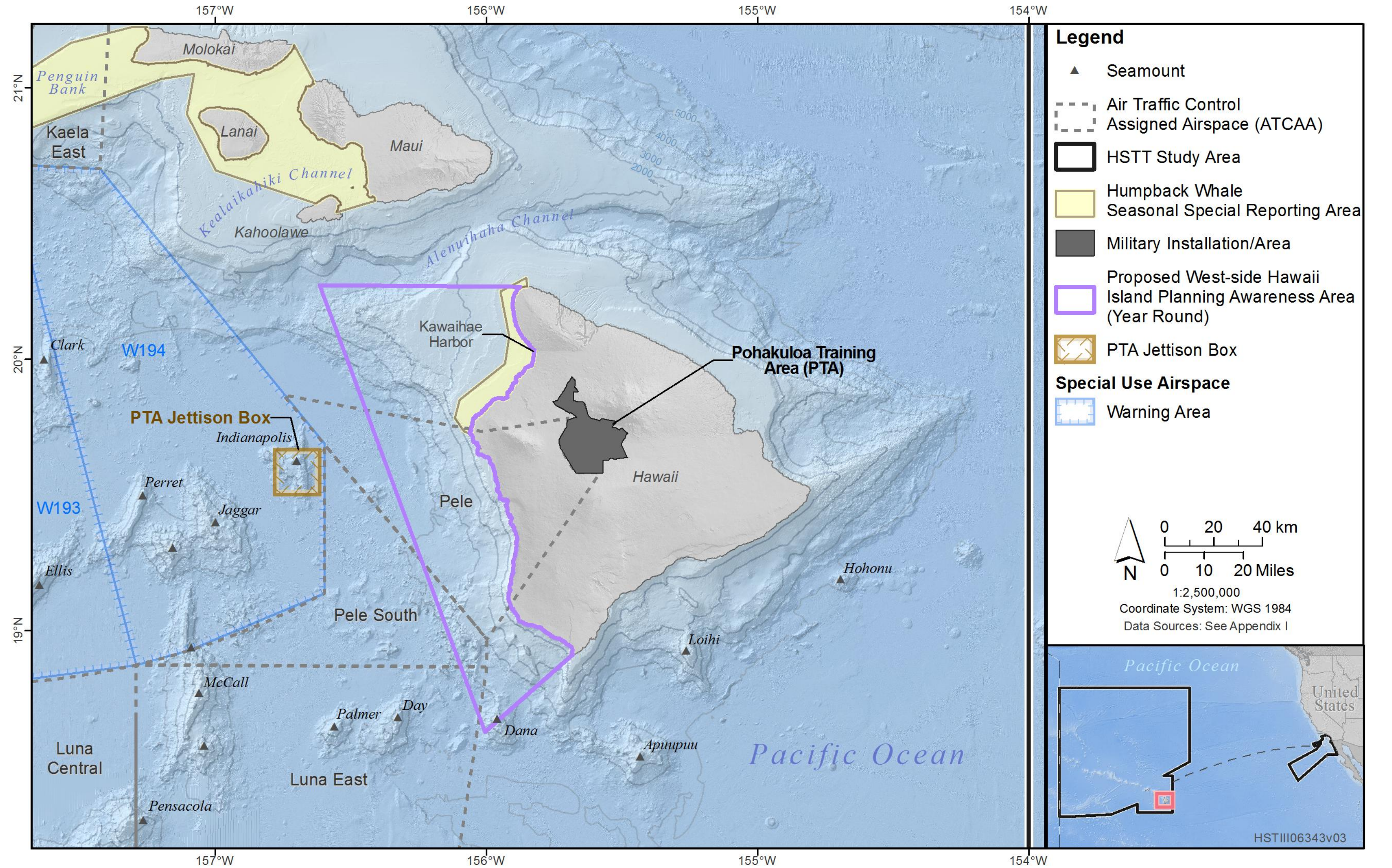


Figure 11-3: West-side Hawaii Island Planning Awareness Area

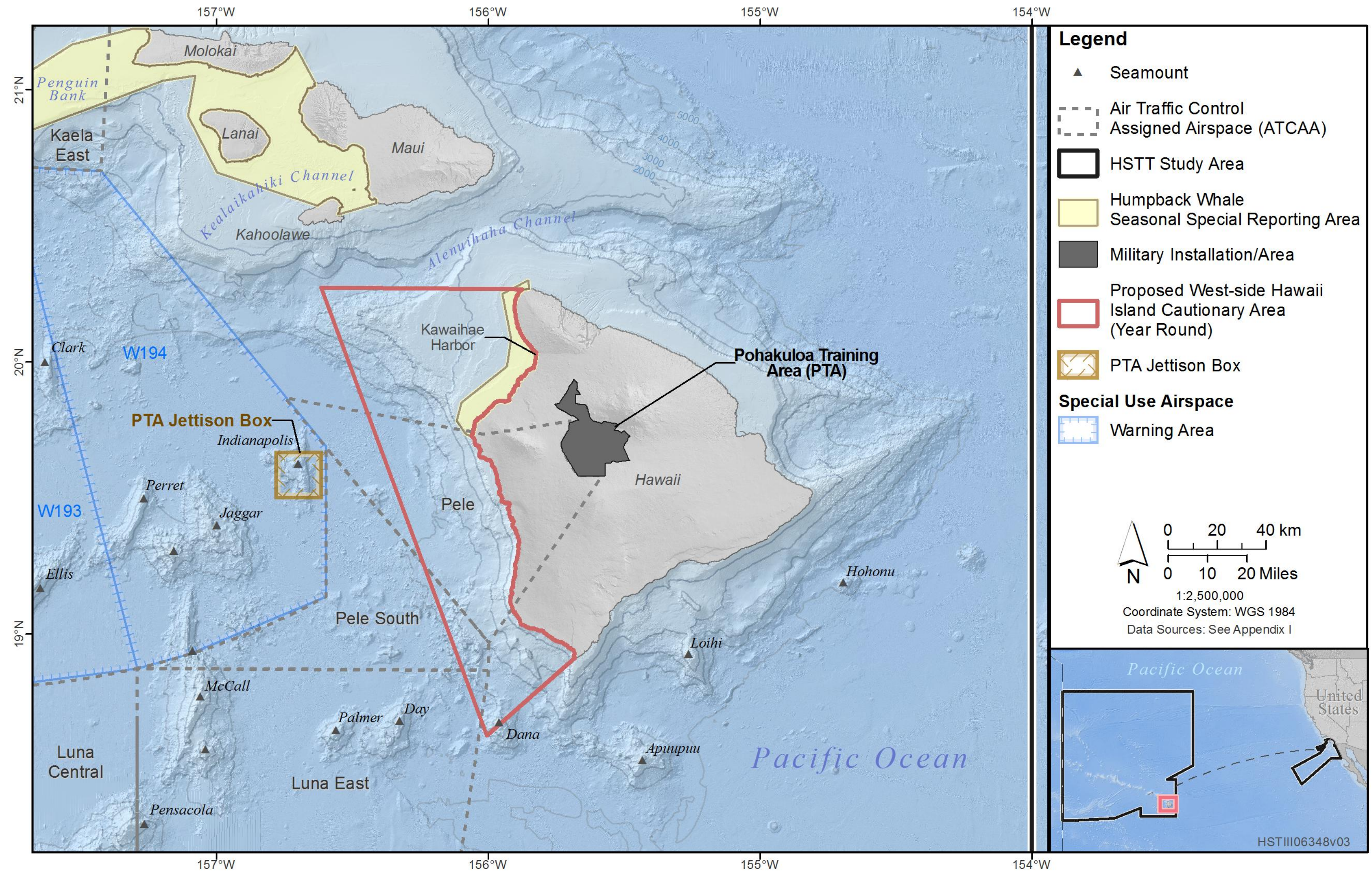


Figure 11-4: West-side Hawaii Island Cautionary Area

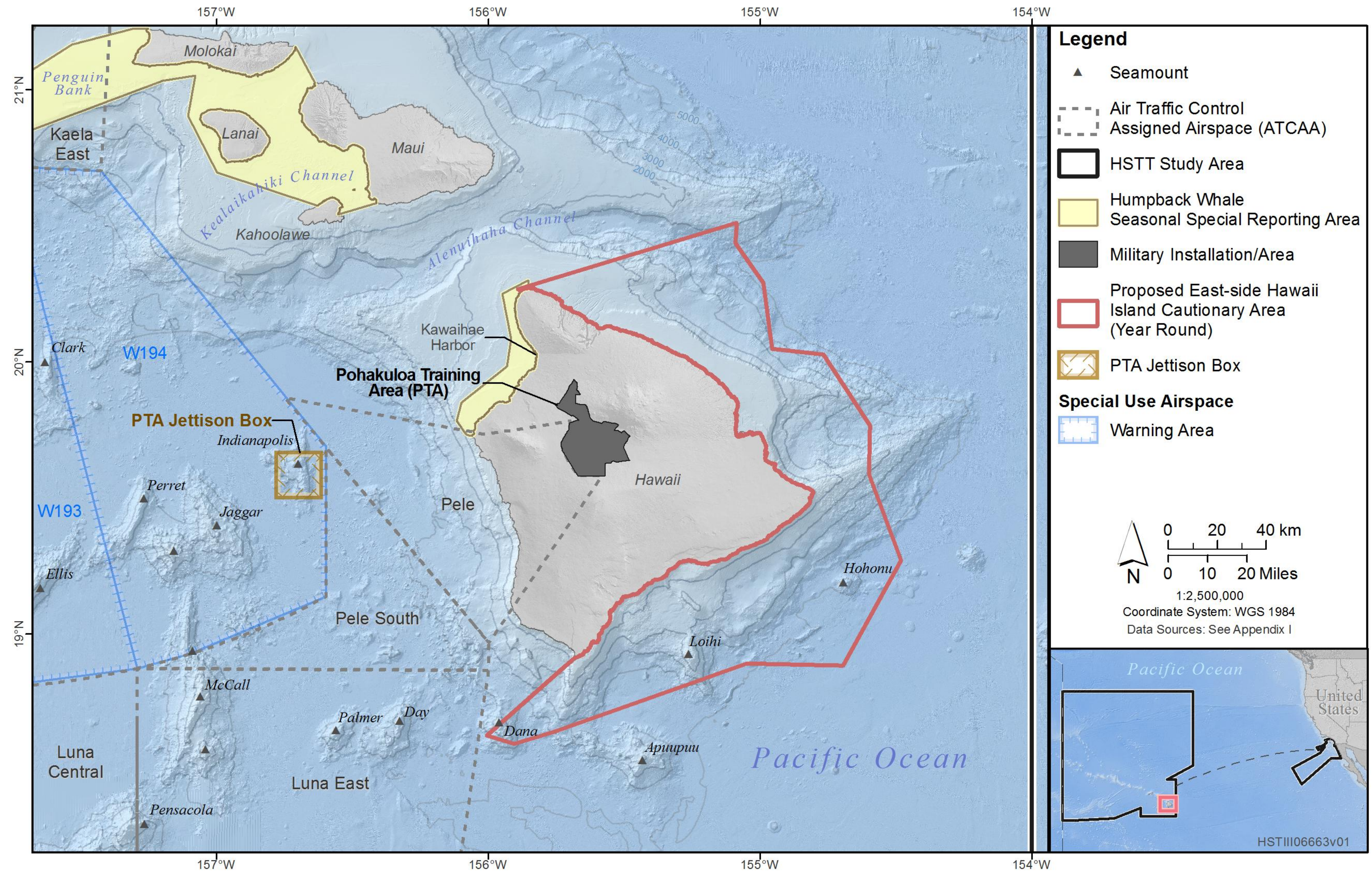


Figure 11-5: East-side Hawaii Island Cautionary Area

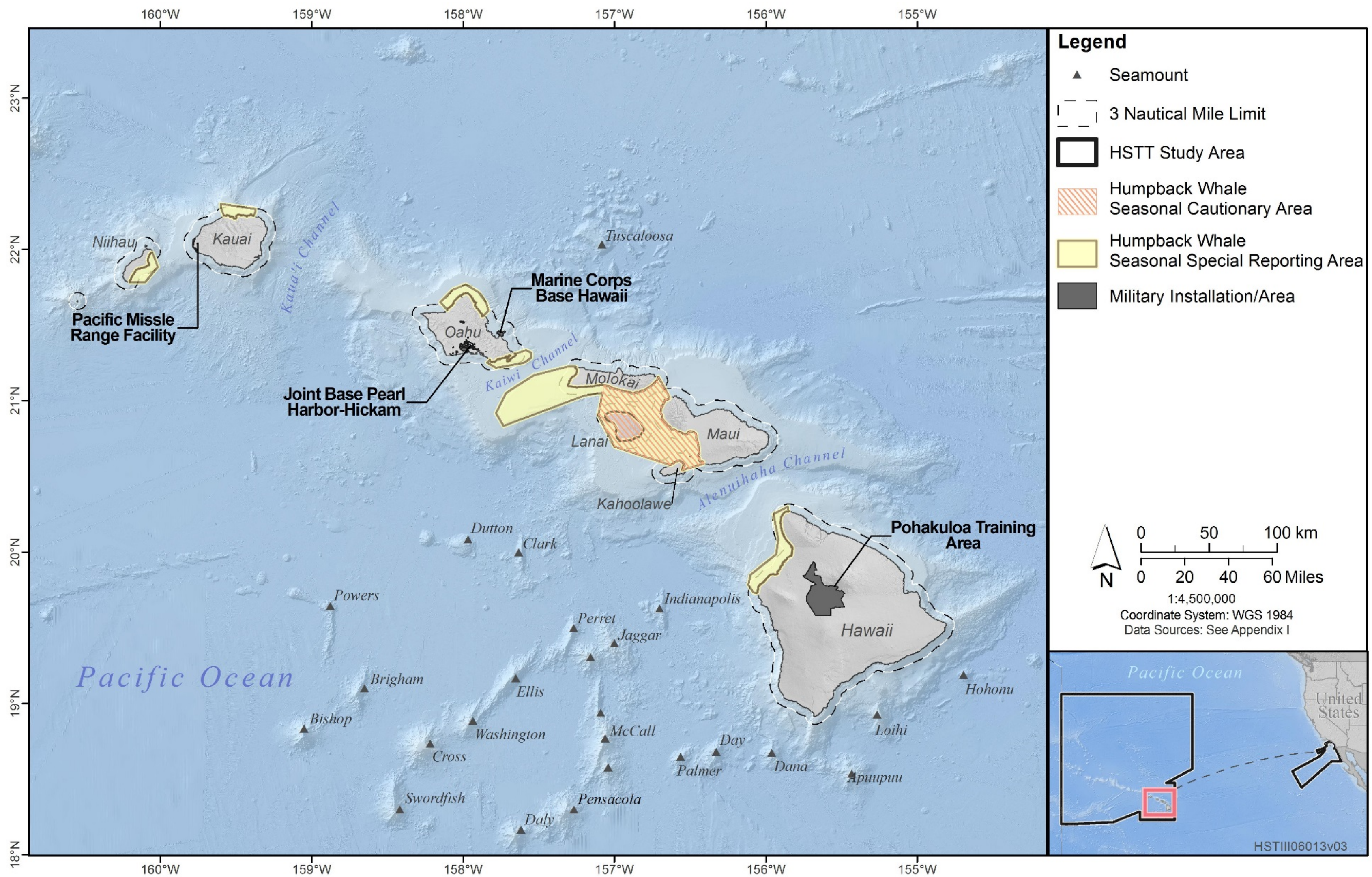


Figure 11-6: Humpback Whale Cautionary Area and Humpback Whale Special Reporting Area

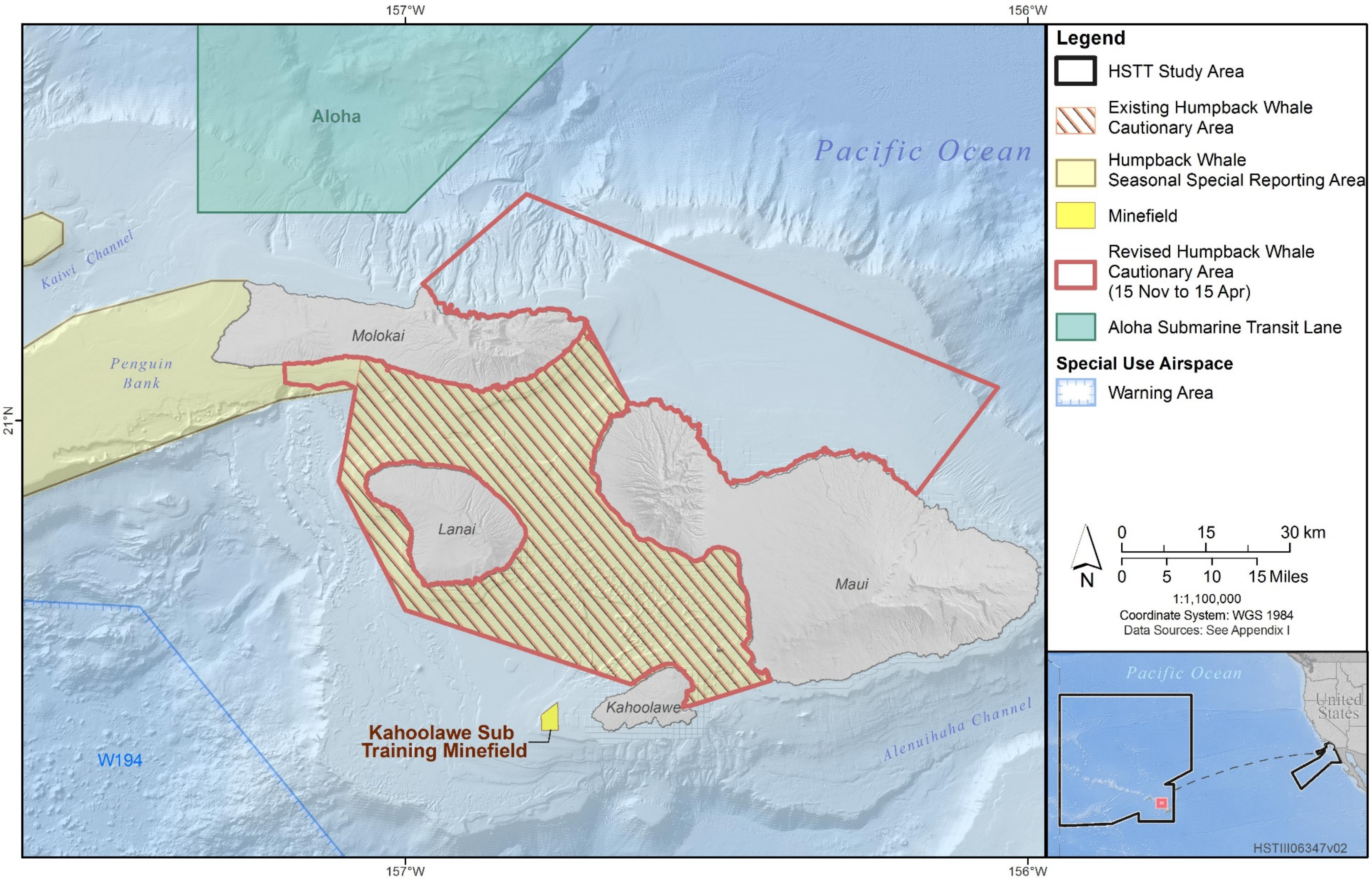


Figure 11-7: Humpback Whale Cautionary Area

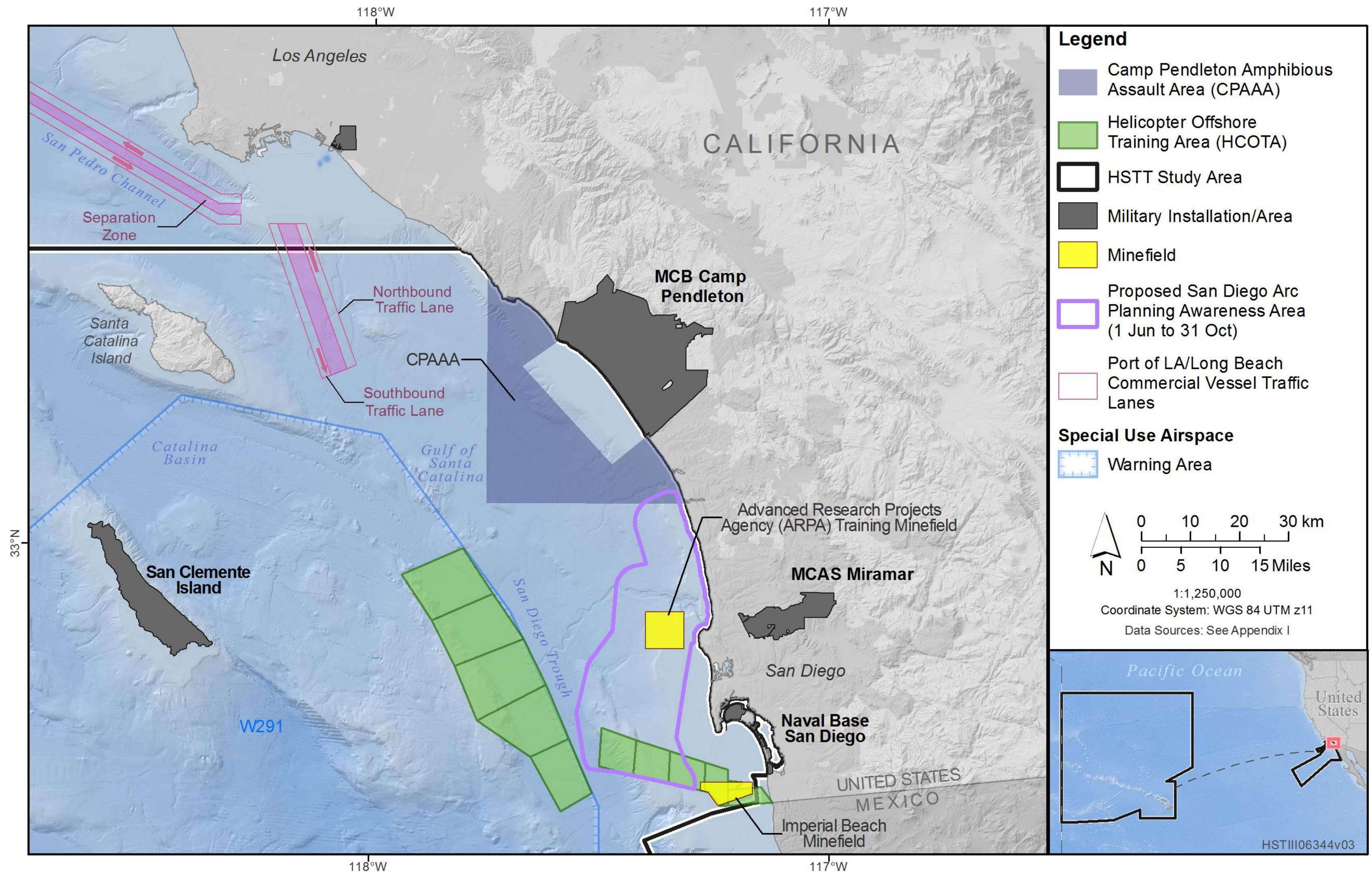


Figure 11-8: San Diego Arc Planning Awareness Area

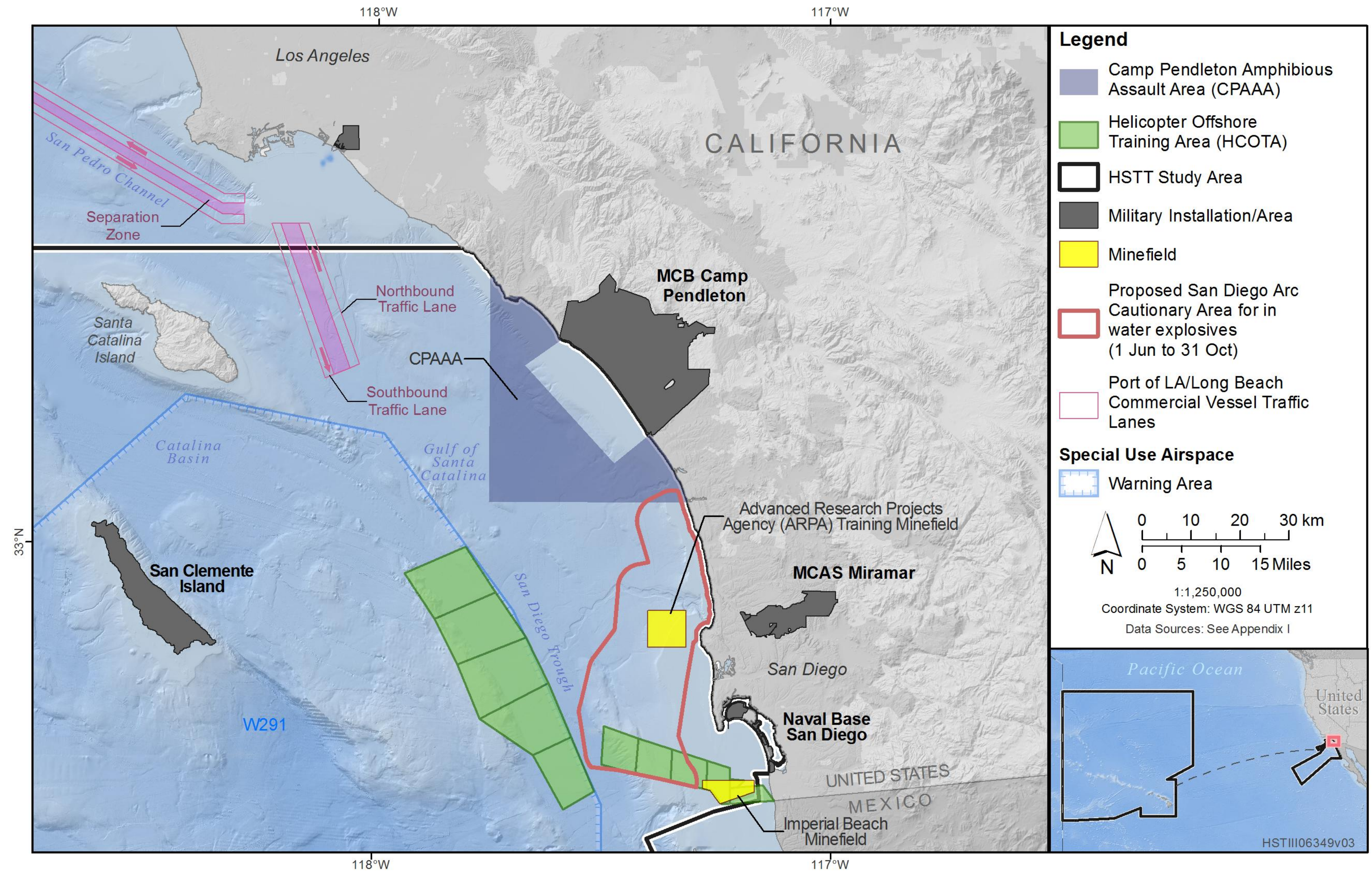


Figure 11-9: San Diego Arc Cautionary Area

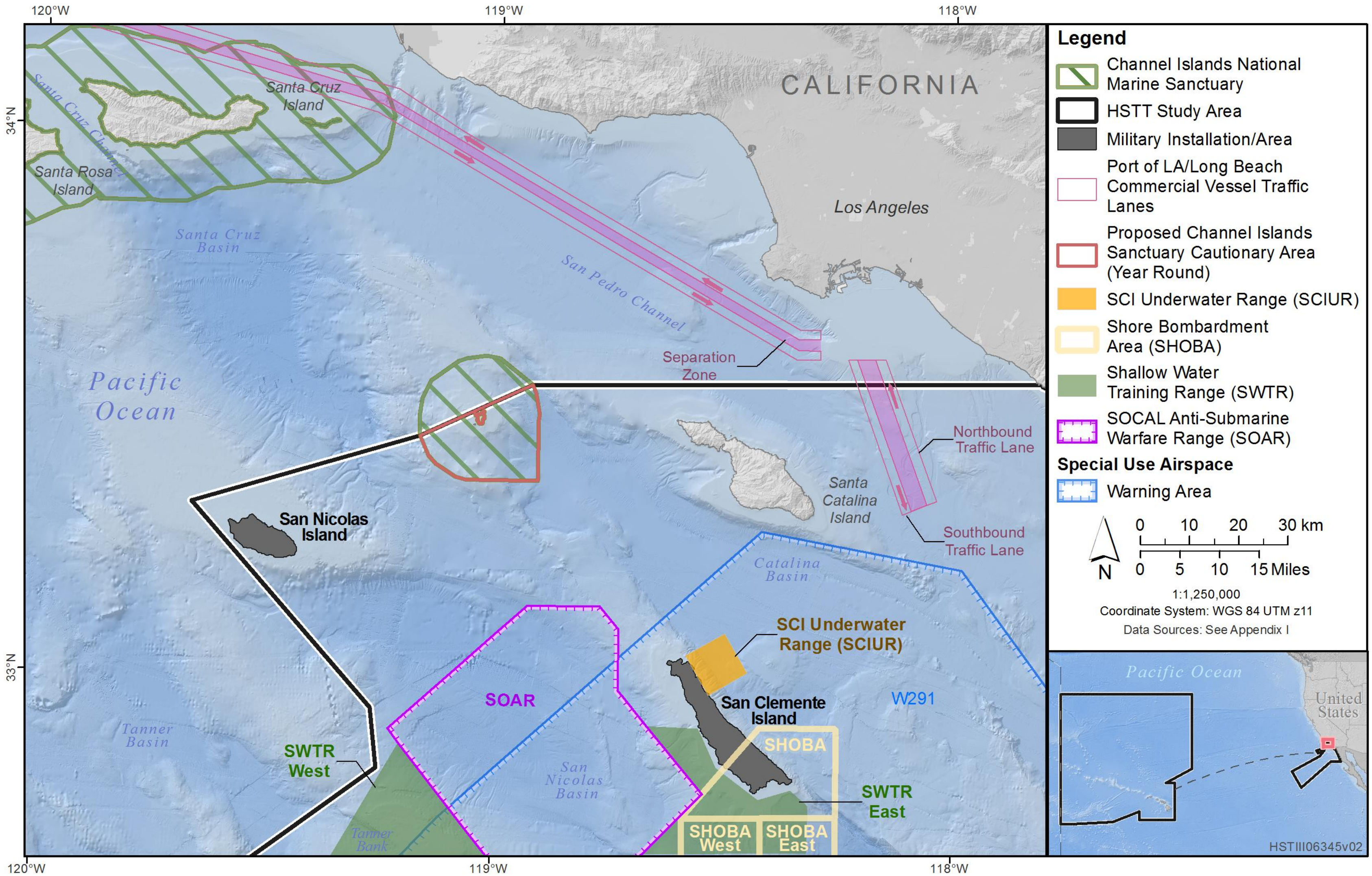


Figure 11-10: Channel Islands National Marine Sanctuary Cautionary Area

11.3 Mitigation Summary

The Navy's mitigation measures are summarized in Table 11-24 and Table 11-25.

Table 11-24: Summary of Procedural Mitigation

Stressor or Activity	*Summary of Mitigation Requirements*
Environmental Awareness and Education	Afloat Environmental Compliance Training program for applicable personnel
Active Sonar (depending on system)	Depending on sonar source: 1,000 yd. power down, 500 yd. power down, and 200 yd. shut down or 200 yd. shut down
Air Guns	150 yd.
Pile Driving	100 yd.
Weapons Firing Noise	30° on either side of the firing line out to 70 yd.
Explosive Sonobuoys	600 yd.
Explosive Torpedoes	2,100 yd.
Explosive Medium-Caliber and Large-Caliber Projectiles	1,000 yd. (large-caliber projectiles); 600 yd. (medium-caliber projectiles during surface-to-surface activities) or 200 yd. (medium-caliber projectiles during air-to-surface activities)
Explosive Missiles and Rockets	900 yd. (0.6–20 lb. net explosive weight) or 2,000 yd. (21–500 lb. net explosive weight)
Explosive Bombs	2,500 yd.
Sinking Exercises	2.5 NM
Explosive Mine Countermeasure and Neutralization Activities	600 yd. (0.1–5 lb. net explosive weight) or 2,100 yd. (6–650 lb. net explosive weight)
Explosive Mine Neutralization Activities Involving Navy Divers	500 yd. (0.1–20 lb. net explosive weight for positive control charges), or 1,000 yd. (21–60 lb. net explosive weight for positive control charges and all charges using time-delay fuses)
Underwater Demolition Multiple Charge – Mat Weave and Obstacle Loading	700 yd.
Maritime Security Operations – Anti-Swimmer Grenades	200 yd.
Vessel Movement	500 yd. (whales) or 200 yd. (other marine mammals)
Towed In-Water Devices	250 yd.
Small-, Medium-, and Large-Caliber Non-Explosive Practice Munitions	200 yd.
Non-Explosive Missiles and Rockets	900 yd.
Non-Explosive Bombs and Mine Shapes	1,000 yd.

Table 11-25: Summary of Mitigation Areas

Mitigation Area	***Summary of Mitigation Requirements***
Mitigation Areas for Seafloor Resources	
Shallow-water coral reefs, Precious coral beds (Year round)	• The Navy will not conduct precision anchoring (except in designated anchorages). • The Navy will not conduct explosive mine countermeasure and neutralization activities, or mine neutralization activities involving Navy divers. • The Navy will not conduct explosive or non-explosive small-, medium-, and large-caliber gunnery activities using a surface target. • The Navy will not conduct explosive or non-explosive missile and rocket activities using a surface target. • The Navy will not conduct explosive or non-explosive bombing or mine laying activities.
Live hard bottom, Artificial reefs, Shipwrecks (Year round)	• The Navy will not conduct precision anchoring (except in designated anchorages). • The Navy will not conduct explosive mine countermeasure and neutralization activities, or mine neutralization activities involving Navy divers.
Mitigation Areas for Marine Mammals	
West-side Hawaii Island Planning Awareness Area (Year-round)	• The Navy will not conduct more than one Major Training Exercise – Large Integrated Anti-Submarine Warfare activity (e.g., Rim of the Pacific) every other year, and three Major Training Exercise – Medium Integrated Anti-Submarine Warfare activities (e.g., Fleet Exercise/Sustainment Exercise) per year using surface ship hull-mounted mid-frequency active sonar. • If additional activities are required for national security, the Navy will provide NMFS with advance notification and include the information in associated reports.
West-side Hawaii Island Cautionary Area (Year round)	• The Navy will not use in-water explosives during unit-level training, major training exercises, or testing events. • If required for national security, naval units will obtain permission from a Command-delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in associated reports.
East-side Hawaii Island Cautionary Area (Year round)	• The Navy will not use surface ship hull-mounted mid-frequency active sonar and in-water explosives during unit-level training, major training exercises, or testing events. • If required for national security, naval units will obtain permission from a Command-delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in associated reports.
Humpback Whale Cautionary Area (November 15 – April 15)	• The Navy will not use surface ship hull-mounted mid-frequency active sonar during training or testing activities. • If required for national security, naval units will obtain permission from a Command-delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification and include the information in associated reports. o Annual use if so needed, will be provide in annual reporting
San Diego Arc Planning Awareness Area (June 1 – October 31)	• The Navy will not conduct more than a combined total of three Major Training Exercise – Large Integrated Anti-Submarine Warfare activity (e.g., Rim of the Pacific) or Major Training Exercise – Medium Integrated Anti-Submarine Warfare activities (e.g., Fleet Exercise/Sustainment Exercise) per applicable season using surface ship hull-mounted mid-frequency active sonar. • If additional activities are required for national security, the Navy will provide NMFS with advance notification and include the information in associated reports. o Annual use if so needed, will be provided in annual reporting
San Diego Arc Cautionary Area (June 1 – October 31)	• The Navy will not use in-water explosives during large-caliber gunnery, torpedo, bombing, and missile (including 2.75" rockets) activities during unit-level training, major training exercises, or testing events. • If required for national security, naval units will obtain permission from a Command-delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification. o Annual use if so needed, will be reported in annual reporting
Channel Islands National Marine Sanctuary Cautionary Area (Year round)	• The Navy will not use surface ship hull-mounted mid-frequency active sonar and in-water explosives used in small-, medium-, and large-caliber gunnery; torpedo; bombing; and missile (including 2.75" rockets) activities during unit-level training, major training exercises, or testing events. • If required for national security, naval units will obtain permission from a Command-delegated authority prior to commencement of the activity. The Navy will provide NMFS with advance notification. o Annual use if so needed, will be reported in annual reporting

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12 Arctic Plan of Cooperation

Subsistence use is the traditional exploitation of marine mammals by native peoples (i.e., for their own consumption). In terms of this LOA request, none of the proposed training or testing activities in the Study Area occurs in or near the Arctic. Based on the Navy discussions and conclusions in Chapter 7 (Impacts on Marine Mammal Species or Stocks) and Chapter 8 (Impacts on Subsistence Use), there are no anticipated impacts on any species or stocks migrating through the Study Area that might be available for subsistence use.

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13 Monitoring and Reporting

Although the Navy has been conducting research and monitoring in the HSTT study area for over 20 years, they developed a formal marine species monitoring program in support of the MMPA and ESA authorizations for the Hawaii and Southern California range complexes in 2009. This robust program has resulted in hundreds of technical reports and publications on marine mammals that have informed Navy and NMFS analysis in environmental planning documents, Rules and Biological Opinions. The reports are made available to the public on the Navy's marine species monitoring website (www.navymarinespeciesmonitoring.us) and the data on the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) (www.seamap.env.duke.edu).

The Navy commits to continue monitoring the occurrence, exposure, response and consequences of marine species to Navy training and testing and to further research the effectiveness of implemented mitigation measures. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible.

Consistent with the cooperating agency agreement with NMFS, monitoring measures presented here, as well as mitigations discussed in Chapter 11 (Mitigation Measures), focus on the requirements for protection and management of marine resources. A well-designed monitoring program can provide important feedback for validating assumptions made in analyses and allow for adaptive management of marine resources. Monitoring is required for compliance with final rules issued under the MMPA, and details of the monitoring program under the Proposed Action have already been developed in coordination with NMFS through the regulatory process for previous Navy at-sea training and testing actions. No changes are anticipated to the monitoring program or reporting that has been conducted to date. However, discussions with resource agencies during the consultation and permitting processes under the Proposed Action may result in changes to the mitigation as described in this document.

13.1 Monitoring, Research, and Reporting Intiatives

The Navy, NMFS and the Marine Mammal Commission have held annual adaptive management meetings and additional meetings as needed. These meetings have provided both agencies with an opportunity to clarify information and provide feedback on progress as well as revise monitoring projects and goals within permit cycles.

Dynamic revisions to the monitoring program as a result of adaptive management review included the further development of the Strategic Planning Process (U.S. Department of the Navy, 2013d), which is a planning tool for selection of monitoring investments, and its incorporation into the Integrated Comprehensive Monitoring Program which was used for subsequent monitoring. Recent monitoring efforts address the Integrated Comprehensive Monitoring Program top-level goals through a collection of specific regional and ocean basin studies based on scientific objectives. The adaptive management review process and reporting requirements serve as the basis for evaluating performance and compliance.

The adaptive management review process is anticipated to continue between the Navy, NMFS, the Marine Mammal Commission, and other experts in the scientific community through technical review meetings and ongoing discussions.

13.2 Integrated Comprehensive Monitoring Program

The Integrated Comprehensive Monitoring Program (U.S. Department of the Navy, 2010) provides the overarching framework for coordination of the Navy's marine species monitoring efforts and serves as a planning tool to focus Navy monitoring priorities pursuant to ESA and MMPA requirements. The purpose of the Integrated Comprehensive Monitoring Program is to coordinate monitoring efforts across all regions and to allocate the most appropriate level and type of monitoring effort for each range complex based on a set of standardized objectives, regional expertise, and resource availability. Although the Integrated Comprehensive Monitoring Program does not identify specific field work or individual projects, it is designed to provide a flexible, scalable, and adaptable framework using adaptive management and strategic planning processes that periodically assess progress and reevaluate objectives.

The Integrated Comprehensive Monitoring Program is evaluated through the Adaptive Management Review process to (1) assess progress, (2) provide a matrix of goals and objectives, and (3) make recommendations for refinement and analysis of monitoring and mitigation techniques. This process includes conducting an annual adaptive management review meeting at which the Navy and NMFS jointly consider the prior-year goals, monitoring results, and related scientific advances to determine if monitoring plan modifications are warranted to more effectively address program goals. Modifications to the Integrated Comprehensive Monitoring Program that result from annual Adaptive Management Review discussions are incorporated by an addendum or revision to the Integrated Comprehensive Monitoring Program as needed.

Under the Integrated Comprehensive Monitoring Program, Navy-funded monitoring relating to the effects of Navy training and testing activities on protected marine species is designed to accomplish one or more top-level goals as described in the Integrated Comprehensive Monitoring Program charter (U.S. Department of the Navy, 2010):

- An increase in the understanding of the likely occurrence of marine mammals and ESA-listed marine species in the vicinity of the action (i.e., presence, abundance, distribution, and density of species).
- An increase in the understanding of the nature, scope, or context of the likely exposure of marine mammals and ESA-listed species to any of the potential stressors associated with the action (e.g., sound, explosive detonation, or expended materials), through better understanding of one or more of the following: (1) the nature of the action and its surrounding environment (e.g., sound-source characterization, propagation, and ambient noise levels), (2) the affected species (e.g., life history or dive patterns), (3) the likely co-occurrence of marine mammals and ESA-listed marine species with the action (in whole or part), and (4) the likely biological or behavioral context of exposure to the stressor for the marine mammal and ESA-listed marine species (e.g., age class of exposed animals or known pupping, calving, or feeding areas).
- An increase in the understanding of how individual marine mammals or ESA-listed marine species respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible [e.g., at what distance or received level]).
- An increase in the understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: (1) the long-term fitness and

survival of an individual; or (2) the population, species, or stock (e.g., through impacts on annual rates of recruitment or survival).

- An increase in the understanding of the effectiveness of mitigation and monitoring measures.
- A better understanding and record of the manner in which the authorized entity complies with the Incidental Take Authorization and Incidental Take Statement.
- An increase in the probability of detecting marine mammals (through improved technology or methods), both specifically within the mitigation zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.
- A reduction in the adverse impact of activities to the least practicable level, as defined in the MMPA.

In 2011, a Scientific Advisory Group provided specific programmatic recommendations that continue to serve as guiding principles for the continued evolution of the Integrated Comprehensive Monitoring Program. Key recommendations include

- Working within a conceptual framework of knowledge, from basic information on the occurrence of species within each range complex, to more specific matters of exposure, response, and consequences.
- Facilitating collaboration among researchers in each region, with the intent to develop a coherent and synergistic regional monitoring and research effort.
- Approaching the monitoring program holistically and selecting projects that offer the best opportunity to advance understanding of the issues, as opposed to establishing range-specific requirements.

13.3 STRATEGIC PLANNING PROCESS

The Strategic Planning Process (U.S. Department of the Navy, 2013d) serves to guide the investment of resources to most efficiently address Integrated Comprehensive Monitoring Program objectives and intermediate scientific objectives developed through this process.

The U.S. Navy marine species monitoring program has evolved and improved as a result of the adaptive management review process through changes that include:

- recognizing the limitations of effort-based compliance metrics;
- developing a conceptual framework based on recommendations from the Scientific Advisory Group (U.S. Department of the Navy, 2013d);
- shifting focus to projects based on scientific objectives that facilitate generation of statistically meaningful results upon which natural resources management decisions may be based;
- focusing on priority species or areas of interest as well as best opportunities to address specific monitoring objectives in order to maximize return on investment; and

- increasing transparency of the program and management standards, improving collaboration among participating researchers, and improving accessibility to data and information resulting from monitoring activities.

As a result, the Navy's marine species monitoring program has undergone a transition with the implementation of the Strategic Planning Process under MMPA authorizations. Under this process, Intermediate Scientific Objectives serve as the basis for developing and executing new monitoring projects across Navy training and testing areas in the Atlantic and Pacific Oceans. Implementation of the Strategic Planning Process involves coordination among fleets, system commands, Chief of Naval Operations Energy and Environmental Readiness Division, NMFS, and the Marine Mammal Commission with five primary steps:

- **Identify overarching intermediate scientific objectives.** Through the adaptive management process, the Navy coordinates with NMFS as well as the Marine Mammal Commission to review and revise the list of intermediate scientific objectives that are used to guide development of individual monitoring projects. Examples include addressing information gaps in species occurrence and density, evaluating behavioral responses of marine mammals to Navy training and testing activities, and developing tools and techniques for passive acoustic monitoring.
- **Develop individual monitoring project concepts.** This step generally takes the form of soliciting input from the scientific community in terms of potential monitoring projects that address one or more of the intermediate scientific objectives. This can be accomplished through a variety of forums, including professional societies, regional scientific advisory groups, and contractor support.
- **Evaluate, prioritize, and select monitoring projects.** Navy technical experts and program managers review and evaluate all monitoring project concepts and develop a prioritized ranking. The goal of this step is to establish a suite of monitoring projects that address a cross-section of intermediate scientific objectives spread over a variety of range complexes.
- **Execute and manage selected monitoring projects.** Individual projects are initiated through appropriate funding mechanisms and include clearly defined objectives and deliverables (e.g., data, reports, publications).
- **Report and evaluate progress and results.** Progress on individual monitoring projects is updated through the Navy Marine Species Monitoring Program website as well as annual monitoring reports submitted to NMFS. Both internal review and discussions with NMFS through the adaptive management process are used to evaluate progress toward addressing the primary objectives of the Integrated Comprehensive Monitoring Program and serve to periodically recalibrate the focus of the monitoring program.

These steps serve three primary purposes: (1) to facilitate the Navy in developing specific projects addressing one or more intermediate scientific objectives; (2) to establish a more structured and collaborative framework for developing, evaluating, and selecting monitoring projects across all areas where the Navy conducts training and testing activities; and (3) to maximize the opportunity for input and involvement across the research community, academia, and industry. Furthermore, this process is designed to integrate various elements, including:

- Integrated Comprehensive Monitoring Program top-level goals,
- Scientific Advisory Group recommendations,
- Integration of regional scientific expert input,
- Ongoing adaptive management review dialog between NMFS and the Navy,
- Lessons learned from past and future monitoring at Navy training and testing ranges; and
- Leveraging of research and lessons learned from other Navy-funded science programs.

The Strategic Planning Process will continue to shape the future of the U.S. Navy Marine Species Monitoring Program and serve as the primary decision-making tool for guiding investments. Information on monitoring projects currently underway in the Atlantic and Pacific oceans, as well as results, reports, and publications can be accessed through the U.S. Navy Marine Species Monitoring Program website (www.navymarinespeciesmonitoring.us).

13.4 MONITORING PROGRESS IN HSTT

The monitoring program has undergone significant changes that highlight its progress through adaptive management. The monitoring program developed for the first cycle of environmental compliance documents (e.g., (U.S. Department of the Navy, 2008)) utilized effort-based compliance metrics that were somewhat limiting. Through adaptive management discussions, the Navy, designed and conducted monitoring studies according to scientific objectives, and eliminated specific effort requirements.

Progress has also been made on the conceptual framework categories from the Scientific Advisory Group for Navy Marine Species Monitoring (U.S. Department of the Navy, 2011e), ranging from occurrence of animals, to their exposure, response, and population consequences. Lessons-learned with Phase I monitoring in HRC and SOCAL suggested that “layering” multiple simultaneous components of monitoring could provide a way to leverage an increase in return of the progress toward answering scientific monitoring questions. For example, in later Phase I HRC monitoring through Phase II HSTT monitoring, several monitoring efforts coincided on the instrumented Navy training range off PMRF during an actual anti-submarine warfare training exercise. The different layers included: a) deploying civilian marine mammal observers aboard a Navy destroyer employing mid-frequency active sonar, b) a civilian marine mammal aerial survey aircraft orbiting the destroyer during the course of the exercise, c) Navy acousticians monitoring the exercise participants and animals via the hydrophones of the instrumented range during the exercise, and d) having satellite tagging of animals performed on the training range just prior to the exercise. This approach of layering different monitoring assets continues to the present day, and each component has grown more technically sophisticated in the pursuit of a monitoring study type known as opportunistic behavioral response study.

Numerous publications, dissertations and conference presentations have resulted from research conducted under the marine species monitoring program (https://www.navymarinespeciesmonitoring.us/reading-room/publications/), resulting in a significant contribution to the body of marine mammal science. Publications on occurrence, distribution and density have fed the modeling input, and publications on exposure and response have informed Navy and NMFS analysis of behavioral response and consideration of mitigation measures.

Furthermore, collaboration between the monitoring program and the Navy’s research and development (e.g., the Office of Naval Research) and demonstration-validation (e.g., Living Marine Resources)

programs has been strengthened, leading to research tools and products that have already transitioned to the monitoring program. These include Marine Mammal Monitoring on Ranges (M3R), controlled exposure experiment behavioral response studies (CEE BRS), acoustic sea glider surveys, and global positioning system-enabled satellite tags. Recent progress has been made with better integration with monitoring across all Navy at-sea study areas, including the Atlantic Fleet Training and Testing Study Area in the Atlantic Ocean, and various testing ranges. Publications from the Living Marine Resources and Office of Naval Research programs have also resulted in significant contributions to hearing, acoustic criteria used in effects modeling, exposure, and response, as well as developing tools to assess biological significance (e.g. consequences).

NMFS and Navy also consider data collected during procedural mitigations as monitoring. Data are collected by shipboard personnel on hours spent training, hours of observation, hours of sonar, marine mammals observed within the mitigation zone during Major Training Exercises, mitigations implemented, etc. This data is provided to NMFS in both classified and unclassified annual exercise reports.

13.5 PROPOSED HSTT NAVY-FUNDED MONITORING

The Navy has been funding various marine mammal studies and research within the HSTT Study Area for the past 20 years. Under permitting from NMFS starting in 2009, this effort has transitioned from a more broad new research only approach, to a specific metric based approach (e.g., set number of visual surveys, specific number of passive acoustic recording devices, etc.), and more currently since 2014 a more regional (Hawaii or Southern California) species-specific study question design (e.g., what is distribution of species A within HSTT, what is response of species B to Navy activities, etc.).

The ongoing regional species-specific study questions and results from recent efforts are publically available on the Navy's Monitoring Program website. In adaptive management consultation with NMFS, some variation of these ongoing studies or proposed new studies will continue within HSTT for either the duration of any new regulations, or for a set period as specified in a given project's scope. Some projects may only require one or two years of field effort. Other projects could entail multi-year field efforts (2-5 years). For instance, in the SOCAL portion of the HSTT study area, the Navy has funded development and application of new passive acoustic technology since the early 2000s for detecting Cuvier's beaked whales. This also includes ongoing effort to further identify and update population demographics for Cuvier's beaked whales (re-sighting rates, population growth, calving rates, movements, etc.) specific to Navy training and testing areas, as well as responses to Navy activity. Variations of these Cuvier's beaked whale monitoring studies will likely continue under future authorizations. The exact combination of final 2019-2023 HSTT monitoring projects will be finalized with NMFS prior to the HSTT proposed rule, and posted on the Navy's Monitoring Program website.

13.6 REPORTING

Under the current LOA and Biological Opinion, the Navy adheres to the following reporting and coordination requirements:

- Major Training Exercise 72-hour pre-notification and post-exercise notification
- Annual marine species Monitoring and Exercise Reports (currently, combined into two overall reports, one for Pacific and one for Atlantic). Specific sub-reporting in these annual reports include:
  - Humpback Whale Special Reporting Area (December 15 – April 15):
    - The Navy will report the total hours of operation of surface ship hull-mounted mid-frequency active sonar used in the special reporting area.
  - Any use that occurred as specifically described in the various HSTT Planning and Cautionary Areas (Chapter 11).
- Annual marine species monitoring technical review meetings with researchers, regulators and Marine Mammal Commission (currently, every two years a joint meeting is held)
- Annual Adaptive Management meetings with NMFS, regulators and Marine Mammal Commission (recently modified to occur in conjunction with the annual monitoring meeting)
- Ship strike notification
- Stranding notification – marine mammal and sea turtles

The Navy will discuss the need to continue all of these requirements with NMFS during the MMPA and ESA consultations.

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14 Suggested Means of Coordination

14.1 OVERVIEW

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities the marine environment including marine mammals. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. There are three pillars to the Navy's monitoring and research program: the Research and Development programs under the Navy's Chief of Naval Operations Energy and Environmental Readiness (OPNAV N45), the Office of Naval Research, and the Fleet/Systems Commands compliance monitoring program. The goal of the Navy's Research and Development program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Research and Development programs are funded and developed by OPNAV N45 and the Office of Naval Research, Code 322 Marine Mammals and Biological Oceanography Program. Primary focus of these programs since the 1990s is on understanding the effects of sound on marine mammals, including physiological, behavioral and ecological effects. The third pillar of the Navy's marine species research and monitoring programs is the Fleet Systems Command compliance program that started in 2009 with the first MMPA permits. Coordination is frequent between the three programs with members of each program sitting on advisory or steering commitees of the others' to facilitate collaboration, transition, and feedback loops to all three.

The Office of Naval Research's current Marine Mammals and Biology Program thrusts include, but are not limited to (1) monitoring and detection research, (2) integrated ecosystem research including sensor and tag development (3) effects of sound on marine life (such as hearing, behavioral response studies, physiology [diving and stress], Population Consequences of Acoustic Disturbance), and (4) models and databases for environmental compliance.

To manage some of the Navy's marine mammal research programmatic elements, OPNAV N45 developed in 2011 a new Living Marine Resources Research and Development (LMR R&D) Program. The goal of the LMR R&D Program is to identify and fill knowledge gaps and to demonstrate, validate, and integrate new processes and technologies to minimize potential effects to marine mammals and other marine resources. The LMR has an Advisory Committee comprised of Navy biologists and staff from the Fleets, Systems Commands, and service providers, providing a nexus for feedback and collaboration for the three pillars of the Navy's Research and Monitoring programs. Key elements of the LMR program include:

- Develop an open and transparent process with a dedicated web site for both project management and public review;
- Provide program management and execution including inputs from various Navy commands involved in monitoring and research;
- Ensure funding of research and development projects that include internationally respected and authoritative researchers and institutions;
- Establish and validate critical needs and requirements with input from a Navy Regional Advisory Committee (RAC);
- Interact with key stakeholders outside of the Navy via the RAC;
- Identify key enabling capabilities and investment areas with advice and assistance from a Navy Technical Review Committee;

- Maintain close interaction and coordination with the ONR basic and early stage applied research program;
- Develop effective information for Navy environmental planners and operators;
- Provide effective management of project funding.

The Navy also collaborates regularly with the Bureau of Ocean Energy Management, NMFS and other federal agencies on projects with mutual goals. Examples are Atlantic Marine Assessment Program for Protected Species, Pacific Marine Assessment Program for Protected Species, and monitoring projects in the Mariana Islands, Hawaii, Southern California and the Atlantic.

14.2 NAVY RESEARCH AND DEVELOPMENT

14.2.1 NAVY FUNDED RESEARCH

Both the ONR and LMR Research and Development (R&D) programs have projects ongoing within HSTT (Southern California and Hawaii). The periodicity and length of these research projects varies from one to three years typically, and are on separate approval and funding cycles from the Integrated Comprehensive Monitoring Program. Depending on a given R&D project's goals, and following evaluation of the science provided, cost effectiveness, regional applicability, and other criteria, some R&D technology or analytical techniques may transition to HSTT projects directly via a new technology, or increase the efficiency of current projects. Examples of the former are R&D funding for development and validation of: a) new or improved satellite tracking tags that are now used in many HSTT cetacean tracking studies, b) the Marine Mammal Monitoring on Navy Ranges systems that are now used at both SCORE and PMRF for acoustic monitoring on instrumented Navy ranges, c) autonomous sea gliders used for acoustic surveys in remote waters of HSTT. Examples of the latter are improvements to species-specific automated passive acoustic detectors for marine mammal vocalizations. Development and testing of some detectors, which help improve the analysis of large passive acoustic datasets, was funded by Navy R&D investments, and improved detectors are now used by researchers conducting HSTT passive acoustic monitoring. Beyond the monitoring program, close integration with the ONR and LMR program also supports improvements in the analyses in the HSTT Draft EIS/OEIS and the associated MMPA and ESA consultations (e.g., new audiograms, risk functions, models, etc.).

Figure 14-1 highlights the interrelationships between Navy R&D programs (ONR, LMR) and Integrated Comprehensive Monitoring Program.

Below are representative Navy R&D funded projects currently either starting or ongoing within the HSTT from 2016-2017.

Southern California:

- A Framework For Cetacean Density Estimation Using Slow-moving Underwater Vehicles, Southwest Fisheries Science Center
- Behavioral audiometry in multiple killer whales (*Orcinus orca*), 2015-2017, National Marine Mammal Foundation
- Biomechanical And Energetic Analyses Of Whale-borne Tag Sensor Data To Assess The Population Consequence Of Acoustic Disturbance, Stanford University
- Blood Oxygen Conservation In Diving Sea Lions: How Low Does Oxygen Really Go?, Scripps Institution of Oceanography, University of California San Diego
- Blue and Fin Whale Density Estimation in the U.S. Pacific Fleet Southern California Offshore Range using PAM Data, 2015-2018, Scripps Institution of Oceanography, University of San Diego

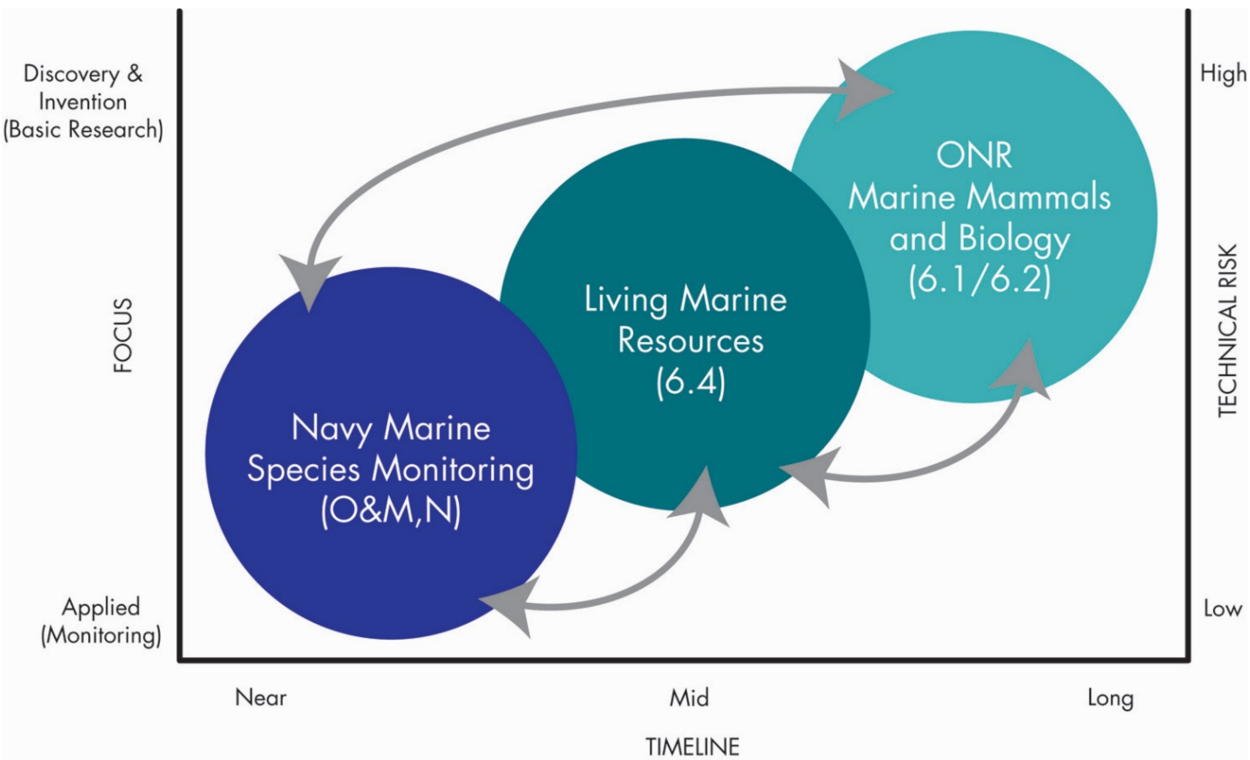
- Cetacean Social Behavioral Response To Sonar
- Cuvier's Beaked Whale and Fin Whale Behavior During Military Sonar Operations: Using Medium-term Tag Technology to Develop Empirical Risk Functions, 2016 – 2020, Marine Ecology and Telemetry
- Database and Metrics for Testing Automated Signal Processing for Passive Acoustic Monitoring in Naval Training Ranges, 2014-2017, Scripps Institution of Oceanography, University of California San Diego
- DECAFTEA: Density Estimation for Cetaceans from Acoustic Fixed sensors in Testing and Evaluation Areas, 2015-2019, University of Saint Andrews
- Demonstration of Commercially Available High-Performance PAM Glider and Profiler Float, 2014-2017, Oregon State University
- Frequency-Dependent Growth and Recovery of TTS in Bottlenose Dolphins, 2016-2019, Space and Naval Warfare Systems Center—Pacific
- Improving the Navy's Automated Methods for Passive Underwater Acoustic Monitoring of Marine Mammals, 2014-2016, Space and Naval Warfare Systems Center—Pacific
- Integrated Real-Time Autonomous Passive Acoustic Monitoring (IRAP) System, 2014-2017, OASIS
- Integrating Remote Sensing Methods To Measure Baseline Behavior And Responses Of Social Delphinids To Navy Sonar, Southwest Fisheries Science Center and Southall Environmental Associates, Inc.
- Interactions Among Behavioral Responses Of Baleen Whales To Acoustic Stimuli, Oceanographic Features, And Prey Availability, University of California Santa Cruz and Southall Environmental Associates, Inc.
- Marine Mammal Monitoring on Navy Ranges (M3R), 2009 -2016, Naval Undersea Warfare Center, Newport, RI
- Measuring Stress Hormone Levels And Reproductive Rates In Two Species Of Common Dolphins Relative To Mid-frequency Sonar, Southwest Fisheries Science Center
- Passive Acoustic Density Estimation of Baleen Whales: Using Sonobuoys to Estimate Call Rate Correction Factors, 2015-2017, Southwest Fisheries Science Center
- Southern California Behavioral Response Study, 2010-2017, Southall Environmental Associates
- Technology Demonstration for Fleet Passive Acoustic Monitoring, 2014-2016, Scripps Institution of Oceanography, University of California San Diego
- Using Passive And Active Acoustics To Examine Relationships Of Cetacean And Prey Densities, Scripps Institution of Oceanography, University of California San Diego

Hawaii:

- A Blainville's Beaked Whale Behavioral Risk Function for Hawaiian Populations, 2016 – 2018, Naval Undersea Warfare Center, Newport RI
- A Framework For Cetacean Density Estimation Using Slow-moving Underwater Vehicles, Southwest Fisheries Science Center [same project as listed for Southern California with Hawaii component]
- Behavioral Response Evaluations Employing Robust Baselines And Actual Navy Training (BREVE), Space and Naval Warfare Systems Center—Pacific and National Marine Mammal Foundation, Inc.
- Developing Tools for Acoustic-Only BRS Studies at Navy Instrumented Ranges, 2016 - 2019, Space and Naval Warfare Systems Center—Pacific

- Development And Validation Of A Technique For Detection Of Stress And Pregnancy In Large Whales, University of Alaska
- Development Of A Multi-week Sound and Motion Recording and Telemetry (SMRT) Tag For Behavioral Studies Of Whales, Wildlife Computers
- Does Depth Matter? Examining Factors That Could Influence The Acoustic Identification Of Odontocete Species On Bottom-moored Recorders, Oceanwide Sciences Institute
- Improving the Navy's Automated Methods for Passive Underwater Acoustic Monitoring of Marine Mammals, 2014-2016, Space and Naval Warfare Systems Center—Pacific
- Integrated Real-Time Autonomous Passive Acoustic Monitoring (IRAP) System, 2014-2017, OASIS
- Marine Mammal Monitoring on Navy Ranges (M3R), 2009 -2016, Naval Undersea Warfare Center, Newport RI
- Understanding the foraging ecology of beaked and short-finned pilot whales in Hawaiian waters, University of Hawaii

The integration between the Navy's ONR and LMR R&D programs, and related Integrated Comprehensive Monitoring Program will continue and improve during this LOA request period as analytical procedures, technology, and new information transitions from R&D to Integrated Comprehensive Monitoring Program (Figure 14-1).



Parenthesis represent Navy funding sources; 6.1/6.2= Basic Research, 6.4= Applied Research, and OM&N (Operation & Maintenance, Navy) = operational funding

Figure 14-1: U.S. Navy Marine Resource Investments From Research To Application

14.2.2 Other Government Funded Research

The Navy also periodically coordinates with, shares information, and on occasionally contributes funding to NMFS' Southwest Fisheries Science Center who conducts marine mammal studies along the U.S. west coast, and Pacific Islands Fisheries Science Center which conducts marine mammal studies within Hawaii. The objective of this coordination is to ensure both agencies are aware of each other's efforts, as well as data and resource gaps when specific projects overlap with the Navy's interests in HSTT.

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